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Traditional vs. Blended: the Effect of Instruction Methods on Sixth Grade Pre-Algebra Students' Performance and Perceptions

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TRADITIONAL VS. BLENDED: THE EFFECT OF INSTRUCTION METHODS ON SIXTH GRADE PRE-ALGEBRA STUDENTS' PERFORMANCE AND PERCEPTIONS

by

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Abstract

TRADITIONAL VS. BLENDED: THE EFFECT OF INSTRUCTION METHODS ON SIXTH GRADE PRE-ALGEBRA STUDENTS' PERFORMANCE AND PERCEPTIONS

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This study examined sixth grade students' math performance under two models of instruction: traditional and blended. Blended instruction requires face-to-face learning with an instructor, but allows students to do a portion of the work independently online. Traditional instruction takes place with an instructor present at all times. One area of interest in this study was the level of procedural knowledge acquired under the two different models of instruction. Results from three different assessments indicated no significant difference between the two groups of students. An additional area of interest was students' preferences in teaching strategies in math and approaches to learning. Results indicated that 85% of the blended students and 90% of the traditional students agreed they wanted to take ownership of their learning. All together, over 70% of the students felt that having the ability to work with the teacher one-on-one or in a small group was important. In addition, 78% of students felt it was important to work at varying paces.

In order to keep up with the demands of a workforce that requires critical thinking, creativity, and collaboration, students have to be at the center of their learning journey and play an active role throughout the process. This requires breaking away from the traditional model of education where teachers are the sole transmitter of information and learning is confined to 42-minute time blocks Monday through Friday. Varying the way in which students access and learn content has the potential to transform educational landscapes in terms of quality and cost. The results from this study add to the research base on blended learning at the elementary level. It also includes implications for key stakeholders to consider as they think more broadly about instruction delivery methods.

Acknowledgments

Heavenly Father,

Words cannot express the gratitude I feel at this very moment. I know the last several years would not have been possible without Your strength. You have walked alongside me, carried me, and lifted me back up again during my times of struggle. Even though I ignored you at times and thought I could do it on my own, you were still there guiding me. I owe everything I am and all that I have to You!

As I reflect back on my childhood, I cannot help but think of the many times my parents, Dave and Ronda Dostal, were sowing seeds with their children and the countless students they taught during their careers. It is amazing to see those seeds in full bloom now, bearing fruit and sowing new seeds. I could not have asked for better role models in servant leadership. I am thankful for my entire family and their unending love and support.

Thank you, Lord, for placing mentors in my life. I know you chose each one specifically to teach me something. I am grateful for my chair, Dr. Kay Keiser, who planted the initial seed of pursing a doctorate degree. I pray that all my professors at the University of Nebraska at Omaha know their impact goes beyond measure. Their passion and vision for education is second to none and I feel blessed to have learned from the best.

I truly felt called by you, Lord, to the teaching profession. Thank you for my job at Westside Community Schools and for the support they have provided me in my professional growth. My colleagues are like a second family and I feel blessed to work in such an amazing district.

Lastly, and most importantly, thank you Lord for my husband and boys. No degree or title can compare to the reward that comes from being a wife and mother. You have blessed our family in so many ways and I pray that we continue to rely on You and Your word to guide and direct us in our daily lives. Amen

Dedication

Trust in the Lord with all your heart and lean not on your understanding; in all your ways, submit to him, and he will make your paths straight. ~Proverbs 3:5-6

This dissertation is dedicated to my 5 T's: Troy, Tyler, Trevor, Trea, and Toby.

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Chapter 1

Introduction

The meaning of 'knowing' [learning] has shifted from being able to remember and repeat information to being able to find and use it. ~Nobel Laureate Hebert Simon

Background

Schools in the 20th century applied a one-size-fits-all system to all students, sorting them into different kinds of workers needed by Industrial Age societies (Gilbert, 2009). Creativity and entrepreneurial thinking are skill sets that are highly associated with job creation in the 21st century (Pink, 2005, Sternberg, 1996), however schools are using the same delivery methods from over a century ago to prepare students for a drastically different society. How must our education landscape change in order to prepare students for their future? The scope and sequence of what students have been traditionally expected to learn must be revisited while exploring a variety of delivery approaches that require student involvement (Hess & Meeks, 2010). Effective school systems guarantee challenging, engaging, and intentional instruction. They also provide students with multiple pathways to success. This means schools must conduct evaluations on existing programs to make judgments about continuation, expansion, or to improve the quality of the program delivery (Fitzpatrick, Sanders, & Worthen, 2011).

This dissertation study examined sixth grade students' math performance and perceptions in one Eastern Nebraska school district. This dissertation focused on two groups of students and two different approaches to math instruction: traditional and blended. Both approaches address the teacher and students' roles and responsibility in learning. The study was exploratory, as it sought to find alternative methods of delivering math instruction. Although it is a single district, it is indicative of the changing educational landscapes of the 21st century and the opportunities it presents for supporting children's individual learning needs and preferences.

Contextual Framework

Two conflicting theories of knowledge, learning, and literacy are the didactic and the critical (Paul, Binker, Jensen, & Kreklau, 1987). In the area of mathematics, the didactic theory places the teacher with the fundamental responsibility for student learning by being the sole transmitter of information. The critical theory, however, places students with increasing responsibility for their own learning. It requires them to exhibit and apply proof of knowledge and understanding by explaining or writing in their own words, the meaning and significance of the knowledge they have just acquired (Paul, Binker, Jensen, & Kreklau, 1987). In traditional (didactic) classrooms, the dominant metaphor for teaching is the teacher as information giver; knowledge flows only one way from teacher to student (Tinzmann et.al, 1990). This contrasts with Lev Vygotsky's Social Development Theory, which promotes learning contexts in which students play an active role in learning (Vygotsky, 1978). The constructivist approach is active learning in which people develop their own understanding based on practice and participation (Oblinger, 2004). Parker and Chao (2007) explained that with constructivism, knowledge is not just given to the learner, it is constructed by reflective learning, collaborative learning, and social activities. The blended learning model is one approach that moves away from the didactic and more towards constructivism.

In the Knowledge Age (21st century), there are many resources that allow students to have voice and choice in how they learn and access information. This includes, but is not limited to, listening to a teacher, working in a small group, watching a video, interacting with an online simulation, learning from a more capable peer, and reading from a textbook. These strategies and methods move away from a didactic teaching approach where the teacher is the sole transmitter of information. A blended model suggests students having a more active role in their learning by giving them voice and choice in *how* they learn, *where* they learn, and *when* they learn. This dissertation focused on two approaches to math instruction (traditional and blended) and their affect on students' performance and perceptions.

Statement of the Problem

If you do what you've always done, you'll get what you've always gotten.
~Tony Robbins

The needs of the Knowledge Age (21st century) are much different than the needs of the Industrial Age (20th century). Pink (2005) said, "We have progressed from a society of farmers to a society of factory workers to a society of knowledge workers" (p. 50). He goes on to say, "And now we're progressing yet again-to a society of creators and empathizers, of pattern recognizers and meaning makers" (p. 50). American employers are searching for a workforce that is skilled, adaptable, creative, and equipped for success, but can schools prepare students to be global citizens by utilizing the same teaching methods from centuries ago?

Patterson (2012) said:

> We know the answers do not lie in today's linear arrangement of students moving through grades and classes in lockstep; nor will it be solitary learning through a computer and screen that monitors every keystroke. (p. 14)

"Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations can be made as needed to promote access and attainment for all students" (NCTM, 2000, p. 12). Textbook companies are providing more and more technological resources for delivering math instruction, and a plethora of online resources are committed to providing a personalized learning experience for students. Although many teachers and educational leaders are eager to re-structure the way math is taught, the methods are still relatively new and most implementations are reported on personal blogs and in online magazines. There seems to be little rigorous research done to measure the effects of this pedagogy (Chen & Jones, 2007; Goodwin & Miller, 2013).

The purpose of this quantitative study was to analyze the performance of sixth grade pre-algebra students in two different teaching environments: traditional and blended. The results of this study provided information to one district and how they deliver math instruction, but also laid the groundwork for further study and implementation. Varying the way in which students access and learn content has the potential to transform educational landscapes in terms of quality and cost. This enables teachers, educational leaders and policy makers to think more broadly about instruction delivery methods.

Research Questions

This study addressed two different groups of students and two different models of delivering math instruction: traditional and blended. The research questions that follow guided this dissertation study.

1. How does the procedural knowledge of students in a traditional math course compare to students in a blended instruction format?
    a. Is there a difference in how the two groups perform on the end-of-course

assessment provided by the textbook?

b. Is there a difference in how the two groups perform on the end-of-course assessment written by district teachers?

c. Does a significant difference exist in how the two groups perform on the Nebraska State Assessment (NeSA-Mathematics)?

2. What are sixth grade pre-algebra students' preferences when it comes to teaching strategies and approaches to learning in math?

Definition of Terms

The following terms are used consistently throughout the study:

Blended Learning: Enriched Virtual Model. Courses that incorporate blended learning methods are classes where a portion of the traditional face-to-face instruction is replaced by web-based online learning (What is Blended Learning?, 2011). Horn and Staker (2015) further defined the enriched virtual model of blended learning as:

> Courses that offer required face-to-face learning sessions, but allow students to do the rest of the work online from wherever they prefer. The in-person meeting requirement is based on student progress; if the student is falling behind, she must meet face-to-face more often (p. 50).

Didactic (Traditional) Learning Model. According to edglossary.org (n.d.), courses that use didactic methods are classes where the teacher has fundamental responsibility for student learning. Furthermore, this model provides all students in a given course with the same type of instruction in a pre-determined amount of time, the same assignments, and the same assessments with little variation or modification from student to student. The didactic model is sometimes used synonymously with traditional learning.

Industrial Age. The second half of the 19th century is a period known as the Industrial Revolution. In Industrial Age schools, trained professionals packaged knowledge into a logical, controlled, cumulative sequence. Students were organized into age-related cohorts who receive this knowledge all together, in the same order, at the same pace (Gilbert, 2009).

Knowledge Age. The Knowledge Age and Information Age are often used synonymously. They both refer to Post-Industrial times, or the 21st century. Citizens of the Knowledge Age need to be able to think and learn for themselves, sometimes with the help of external authorities and/or systems of rules, but, more often, without this help (Gilbert, 2009).

Personalized Learning. According to edglossary.org (n.d.), the term personalized learning, or *personalization*, refers to a diverse variety of educational programs, learning experiences, instructional approaches, and academic-support strategies that are intended to address the distinct learning needs, interests, aspirations, or cultural backgrounds of individual students.

Learning Environment. According to edglossary.org (n.d.), the term Learning Environment encompasses the culture of a school or class—its presiding ethos and characteristics, including how individuals interact with and treat one another—as well as the ways in which teachers may organize an educational setting to facilitate learning—e.g., by conducting classes in relevant natural ecosystems, grouping desks in specific ways, decorating the walls with learning materials, or utilizing audio, visual, and digital technologies. Since the qualities and characteristics of a learning environment are determined by a wide variety of factors, school policies, governance structures, and other features may also be considered elements of a "learning environment."

Learning Unit: A series of lessons focused on a specific topic or common theme, such as a chapter in a mathematics textbook.

Flipped Learning. According to flippedlearning.org (n.d.), flipped learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

Assumptions

This dissertation was based on the following assumptions:

1. All students qualified for pre-algebra based on the district's qualifications.
2. The sixth graders were intrinsically motivated to learn and fully participate in the course.
3. The same textbook and resources were identical across the two methods of instruction.

Limitations

There were two unavoidable limitations to this study.

1. The study was limited to one group of forty-five students in a sixth grade pre-algebra course offered in an Eastern Nebraska school district during the 2015-16 school year. Students were placed in the two instructional groups based on convenience. The traditional group contained fifteen students from the same elementary school, while the blended group contained thirty students from seven

different elementary schools.

2. The researcher involved in the study was the instructor for the blended course.

Delimitations

This dissertation examined the topic through the lens of one select population and has the following delimitation:

1. Due to the population and student data-access, this dissertation was limited to one district in an Eastern Nebraska school district. The findings and results of this study may or may not generalize to other subject areas, grade levels, or other methods of instruction

Significance of the Study

Technology will be the backbone, if you will, that helps customize, individualize, and personalize learning for students who doubtless will have different needs at different times. ~Michael Horn

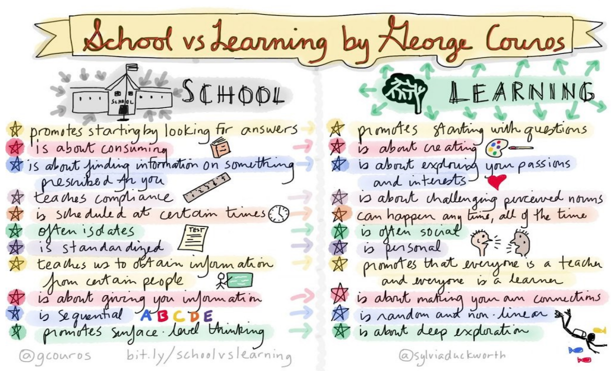


Figure 1: School vs. Learning
(Duckworth, 2014) Retrieved from http://georgecouros.ca/blog/archives/4974

The needs of the Knowledge Age (21st century) are much different than the needs of the Industrial Age (20th century), yet if a present day mathematics classroom were compared to one from the 1950's, many characteristics would be the same. A redefinition of what it means to teach and learn mathematics is critical if schools aim to prepare students for a workforce that demands skilled, adaptable, and creative thinkers. This redefinition is not possible if schools continue to perpetuate the idea that mathematics content is only delivered by a certain person (teacher), for a set amount of time at a certain time each day. No longer can mathematics be isolated to surface-level thinking on a broad range of individual topics. Learning mathematics requires challenging perceived norms and requiring students to explore, make connections, and create meaning.

Blended instruction is becoming a more prevalent instructional method and it is imperative that strategic plans be created in order to provide direction and focus towards appropriate pedagogical techniques (Bonk, Kim, & Zeng, 2006). Blended learning definitely challenges perceived norms in mathematics teaching and learning. Research studies that examine blended learning models at the elementary level are needed in order to provide educators with evidence of its success and offer suggestions to apply the model systematically. Although this study involved one district and how math instruction is delivered to a single grade level, the implications may enable teachers, educational leaders and policy makers at the local, regional, and national level to think more broadly about instruction delivery methods.

Outline of the Study

This dissertation is organized into six chapters. Chapter 1 provides the background, contextual framework, and the need for the study. Chapter 2 presents a review of the literature related to the topic, emphasizing prior research on alternative instruction delivery models. Chapter 3 outlines the research design and methodology used to investigate the research questions. Chapter 4 presents the results of the data analysis and findings. Chapter 5 includes a summary of the study, discussion of the findings, and recommendations for future studies.

Chapter 2

Review of Literature

In much of society, research means to investigate something you do not know or understand. ~Neil Armstrong

Introduction

Education is buzzing with acronyms like PBL and MOOCs and educational reform ideas like the flipped classroom, blended learning, and personalized learning plans. Much of the discussion centered on this verbiage is due to the plethora of technology tools available and the power it brings to teaching and learning. Project Based Learning (PBL) and Massive Open Online Courses (MOOCs) are just two of the many education delivery approaches that allow for personalized education and increased engagement of students. Flipped classrooms and blended learning are two types of environments teachers can create to increase students' accountability of their learning. Finally, personalized learning plans are created for each student to do exactly what the term suggests...provide personalized learning that matches the student's interests and preferred learning style. It could be argued that these delivery approaches and learning environments are just a "new wave" in education, however the history of education reveals their strong roots.

History of Personalization

Distance learning, one-on-one tutoring, gifted education, Individual Education Plans (IEPs), and Community-Based Learning (CBL) are just a few of the many ways in which education has been, and still is personalizing education for students. The geographic distance between educational institutions and rural populations has always existed. Distance learning can be traced back to the late 1800's when Penn State was one of the first universities to develop a program of correspondence study (Banas & Emory, 1998). Budgets are tight and schools must decide on cost-effective ways to personalize education for students. Distance learning opportunities may be one solution.

One-on-one tutoring has been used since the early days in most cultures. Education in early times was highly personal with oral histories being passed from adults to children, informal or formal apprenticeships, and one-on-one tutoring (Maria, 2011). In 1984, Benjamin Bloom determined that targeted small-group instruction improved student learning by 84%, in comparison with students who were taught as a whole group (Bloom, 1984). Educational leaders today are faced with the challenge of providing one-on-one opportunities within the school day for all students, while staying within the ever-shrinking budget.

Gifted education and Individualized Education Plans (IEPs) provide personalized ways of educating specific populations of students. Gifted education encompasses a broad range of practices, procedures, and theories used with students who have been identified as gifted or talented. While there is no global definition of what a gifted student is, federal regulations have defined what it means for a student to have a disability. Under the Individuals with Disabilities Education Act (IDEA), an IEP is mandated for students who have been found to have a disability. Whether a student is identified as gifted or with a disability, special consideration is given to how the student learns and how he/she best demonstrates their learning. All those involved with the child's education do their best to meet the individual needs of the student so that he/she can learn more effectively. One might argue that *all* children deserve this treatment.

Community-based learning unites strategies designed to engage students in learning at high standards, including academically based community service, civic education, environmental education, place-based learning, service learning, and work-based learning (Melaville, Berg, & Blank, 2006). The Community-based School Environmental Education Project (CO-SEED) in New England helps schools and communities work together to develop community- and place-based approaches to education while simultaneously increasing social capital and preserving the environment (PEER Associates, 2004). The program's hypothesis is that if they implement comprehensive place-based education in schools, they will have a positive impact on academic achievement, environmental stewardship behavior, community vitality, and environmental quality. Results from a comprehensive evaluation of CO-SEED showed increase in student engagement in learning, academic achievement, and knowledge about the social and natural environment (PEER Associates, 2004). Many schools have vision statements and strategic plans stating that they want students to be globally competent citizens and possess the skills necessary to enter a meaningful career or career pathway. Community-based learning strategies help students and schools achieve academic, civic and moral, social and personal, and work-related goals (PEER Associates, 2004).

Distance learning, one-on-one tutoring, gifted education, Individual Education Plans, and Community-Based Learning are all ways in which specific student populations in unique circumstances have been, and continue to receive personalized learning opportunities. Personalization is not just a "new wave" in education, but has historical roots in education.

Types of Learning

In order for teachers, administrators, superintendents, and policymakers to make informative decisions regarding alternative instructional approaches and learning environments for students, it is important to have common definitions. First and foremost, it is important to consider what is defined as learning. Bonk (2012) defined *informal learning* as a self-directed activity that takes place at any time one wishes and could be part of one's schoolwork, family life, leisure pursuits, or work activities. He goes on to define *extreme learning* as activities that involve learning with technology in unusual or unique ways, including that which occurs on boats, planes, trains, or buses, as well as when hiking, running, and walking (Bonk, 2009a). Whether it is tagged as formal, informal, or extreme, learning is the acquisition of knowledge or skills through experience, practice, or study, or by being taught. It is also important to note that learning takes place throughout one's lifetime in a variety of delivery approaches.

The term online learning is used to describe programs or courses that use the Internet to provide instructional materials and facilitate interactions between teachers and students. Online learning can be fully online, with all instruction taking place through the Internet, or online elements can be combined with face-to-face interactions in what is known as blended learning (Horn & Staker, 2012). According to the Clayton Christensen Institute (n.d.), the enriched virtual model of blended learning is a course or subject in which online learning is the backbone of student learning, even if it directs students to offline activities at times. Students move on an individually customized, fluid schedule among learning modalities. The teacher of record is on-site, and students learn mostly at the brick-and-mortar campus. The teacher of record (or other adults) provides face-to-face support on a flexible and adaptive, as-needed basis through activities such as small-group instruction, group projects, and individual tutoring. In some blended learning environments, teachers adopt a flipped classroom approach where lectures are recorded and posted online for students to watch outside of class reserving in-class time for more hands-on labs and one-on-one assistance. Blended learning is not a process of posting lectures and scanning worksheets for students to print and complete. That is taking an already broken approach to teaching and superficially adding technology. When implemented correctly, blended learning environments allow for flexibility and self-pacing, which in turn can motivate students and individualize instruction.

There is a small research base for how well blended learning environments are doing. The Flipped Learning Network reported that in one survey of 453 teachers who flipped their classrooms, 67% reported increased tests scores; 80% reported improved student attitudes; and 99% said they would flip their classrooms again next year (Student and Teacher Engagement, 2012). Clintondale High School in Michigan saw the failure rate of its 9th grade math students drop from 44 to 13% after adopting flipped classrooms and juniors taking the state math exams improved by 10% over the previous year (Finkel, 2012). The Falcon Virtual Academy in Colorado Springs, Colorado has also demonstrated success with blended learning. They have an 89.5% graduation rate and a dropout rate of less than 2%. Educators who flip their classrooms say it increased their ability to differentiate instruction. Students are able to work at their own flexible pace in the classroom and receive one-on-one help from a teacher or other student as needed. Teachers can also provide more challenging work for those students who quickly move through the material. Teachers of special populations such as special education and English language learners (ELL) are among the loudest advocates for flipped learning. Students can pause and rewind videos and watch as many times needed. Closed captioning options provide ELL and hearing impaired learners with the opportunity to hear and see the English. The evidence from a 2009 study at Round Rock Independent School District in Texas strongly suggests increased achievement of ELL students in a digital rich classroom compared to ELL students in a traditional classroom (López, 2010).

Whether it is formal, informal, or extreme, learning takes place throughout one's lifetime. Technology is one tool that has increased access to knowledge. It has also provided an abundance of choice in how, when, and where information is accessed. Learners embracing this idea of abundance are taking charge of their learning and making it a more personal experience.

Learning Environments and Scheduling

Technology is not the only thing to consider when searching for alternative instructional approaches. Many schools are adjusting the learning environment by rearranging furniture and physical space to align with the principles of student agency, flexibility, and choice (Horn & Staker, 2015). The learning environment refers to the diverse physical locations, contexts, and cultures in which students learn. According to edglossary.org, the term also encompasses the culture of a school or class, including how individuals interact with and treat one another—as well as the ways in which teachers may organize an educational setting to facilitate learning. Figure 2 provides examples of the shifts taking place in schools with regards to architecture, furniture, and learning spaces.

Program	Description
Ridge Middle School	In Mentor, Ohio, math teacher Tommy Dwyer removed desks to create a more open space. He covered the walls with Plexiglas boards on which students can do their work, which had the added effect of removing any sense of the front of the classroom. Students sit in groups around tables. Their chairs are on wheels so they can scoot themselves to the wall to use the Plexiglas boards as scrap paper.
Columbus Signature Academy	The architects of this school in Columbus, Ohio decided not to use the word "classroom" anymore. Instead, they call all the spaces "studios." The footprint of each studio is double-sized and houses a double group of students in a two-teacher cohort. The interior of the building has either no walls or glass separating studios from corridors and breakout spaces.
Oakdale Elementary	Two 6th grade teachers decided to have the wall between their classrooms tore down. At any given point during the day, students can be found working independently, in small groups, or one-on-one with a teacher or specialist.
Montessori	The Montessori school environment is arranged according to subject area. Children are free to move around the room instead of staying at desks and there is no limit to how long a child can work on something he/she has chosen. A sparse environment of carefully chosen materials calls the child to work, concentration, and joy (2015).
The Free School	Founded in 1969, The Free School in Albany New York provides a unique alternative to traditional models of education. A backyard garden and a 200 acre tract of woods allow the students to explore the great outdoors on a daily basis. The kitchen is a fully functioning classroom where two hot meals are prepared every day. Students learn wilderness skills and explore the world with all of their senses, experiment in the environment, and communicate their discoveries to those around them (n.d.)
Zoo Academy	Since 1995, Omaha's Henry Doorly Zoo and Aquarium has been involved in a strong partnership with local school districts to provide advance high school zoology course and career exploration. In 2009, the Zoo Academy program expanded to a full day high school for Juniors and Seniors. Students are able to complete required science, math, Social studies and English classes at the Zoo (n.d.).
Omaha Public School's Career Center	The Career Center offers high schools students the opportunity to learn about 14 career fields including automotive technology, commercial design, and culinary skills. Students can intern with local businesses and even earn college credit while in high school.

Figure 2: School Design and Learning Environments
Adapted from Blended, Horn & Staker (2015) p. 207

In addition to adjusting the learning environment, many schools are redefining the master schedule. A reprint of the 1994 Report of the National Education Commission on Time and Learning entitled *Prisoners of Time* (2005) stated:

> The six-hour, 180-day school year should be relegated to museums, an exhibit from our education past. Both learners and teachers need more time—not to do more of the same, but to use all time in new, different, and better ways. The key to liberating learning lies in unlocking time (p. 8).

The Carnegie Unit has influenced the overall organization of schools for decades, however, reformers suggest that prioritizing time students spend in courses has caused policymakers and education practitioners to not pay attention to what students are actually learning, or not learning (Silva, White & Toch, 2015). The Obama Administration supported flexibility and autonomy with regards to the structure and format of the school day with the U.S. Department of Education's Race to the Top funds (2009). Twelve of the sixteen school districts that received Race to the Top funds proposed projects that transition away from strict adherence to time-based measures of student learning (Silva, White & Toch, 2015). In some situations, schools are allowing the students to be in control of their schedule. For example, at FLIGHT Academy in Waukesha, Wisconsin, students have the flexibility to build and maintain their own schedule to meet program requirements (FAQ's, n.d.). At Westside High School in Omaha, Nebraska, a modular schedule allows students to be involved in making decisions regarding their use of time. According to their website (Modular Schedule, n.d.):

> All students have a certain amount of time each day when they are not scheduled

> into classes. This time is called “independent study time”. During independent study time, students make decisions about how to best use the time to meet their responsibilities. They may work in instructional materials centers (IMCs) on class assignments or on materials of personal interest. Most students meet regularly with teachers during independent study time for help in a subject or for clarification of assignments. This time may also be used for conferences with counselors and advisors.

Kohn (1993) stated there is nothing new about the idea of students being able to participate, individually and collectively, in making decisions. He goes on to say the best predictor of burnout is not too much work, too little time, or too little compensation. Rather, it is powerlessness or a lack of control over what one is doing. According to Hanover Research (2012), although the concept of personalized learning is relatively new in the educational arena, the theory rests on the assumption that given the ability to self-direct their learning, students will make greater gains in achievement due to increased interest and customization (p. 7). Leveraging technology in a restructured school environment that allows students to self direct their learning might be the proper formula for redefining schools in the 21st century.

Today’s Learners

The 21st century is all about personalization. Twitter suggests people to follow based on key words from tweets, and Facebook suggests friends to follow based on the demographics entered when the account was created. Amazon suggests items to purchase based on recent purchases, and Google customizes specific ads to display based on recent purchases and search histories. The Internet provides an infinite amount of information about any topic, and while filtering the information can sometimes pose problems, 21st century learners are becoming more accustomed to "Google-ing" answers. When the answers to questions are at their fingertips, learners are questioning the more traditional instructional methods used in schools and wonder if they will be prepared for their future. Phi Delta Kappa (PDK) International's 2012 poll found that only 18% feel high school graduates are prepared for the workplace, and one-third believes high school graduates are ready for college (p.14). What needs to happen within our school systems so that all students feel confident in their preparation for the world of work, college, and as a global citizen?

On August 4-6, 2010, 150 education leaders selected for their vision, leadership, and expertise with personalized learning, convened for a symposium hosted by SIIA (The Software & Information Industry Association), ASCD (Association for Supervision and Curriculum Development), and CCSSO (The Council of Chief State School Officers). Symposium participants jointly identified the following top ten essential elements and policy enablers of personalized learning (p. 7):

1. Flexible, Anytime/Everywhere Learning
2. Redefine Teacher Role and Expand "Teacher"
3. Project-Based, Authentic Learning
4. Student Driven Learning Path
5. Mastery/Competency-Based Progression/Pace
6. Redefine Use of Time (Carnegie Unit/Calendar"
7. Performance-Based, Time-Flexible Assessment
8. Equity in Access to Technology Infrastructure

9.Funding Models that Incentivize Completion

10. P-20 Continuum and Non-grade Band System

John Dewey (1966) believed that learning was active and schooling was unnecessarily long and restrictive. He advocated for a balance between delivering knowledge, while also taking into account the interests and experiences of the student. Dewey said, "Education is life itself" and over one hundred years later, his philosophy lies at the heart of many bold educational experiments. Dennis Littky's Met Center (Metropolitan Regional Career and Technical Center) is where students spend more time out in the world learning through internship and less time in classrooms. Littky said, "From the way we design curricula and standards to the way we design schools, we must think of the individual and what he or she *needs* and *wants* from education. Truly personalized learning requires reorganizing schools to start with the student, not the subject matter (Littky & Allen, 1999). For this reason, Met uses individualized learning plans, which are designed by the student's learning team including family members, advisor, and internship mentor. The Coalition of Essential Schools (CES) is also at the forefront of creating and sustaining personalized, equitable, and intellectually challenging schools (2013). In 1984, Theodore Sizer founded the CES and brought together examples of radical school restructuring. Based on decades of research and practice, Sizer's CES Common Principles provide a guiding philosophy for educators who are successfully engaged in creating personalized, equitable, and academically challenging schools for all young people (About CES, 2013). The Southern Region Education Board (SREB) as another example of how personalized education works in the nationwide High Schools that Work (HSTW) model. HSTW has identified key practices that impact school achievement, one of them being the need for extra help. By providing a structured system of extra help to assist students in completing accelerated programs of study with high-level academic and technical content, students are able to become independent learners and practice habits of successful learners such as study and literacy skills, time management, and learning with others (HSTW, n.d.). The Re-Inventing Schools Coalition (RISC) approach to schooling also incorporates personalization where students are encouraged to move in and out of levels in different content areas, at their own pace. Students own, lead, and partner with their teachers in every phase of learning including goal setting, tracking progress, student-teacher conferences, and even assessment (Reinventing Schools, 2013).

The What Matters Most framework by McRel identifies five essential practices that can greatly increase students' chances of doing well in school (Goodwin, 2010). One of those practices is guaranteeing that instruction is challenging, engaging, and intentional. This includes providing students with challenging and personalized learning experiences that prepare them for life success. When whole-child student supports are in place, students are provided with the scaffolding they need to succeed-a just-in-time, personalized response to students' cognitive, psychosocial, and academic needs (Goodwin, 2010). The Chugach School District in Alaska provides separate learning pathways for all students. The small remote village has become recognized as an innovator in grassroots school reform and it all began with the community guiding the school through difficult-to-answer common sense questions (Crumley, 2014):

- Should we expect all students to learn the same material, in the same way, at the same pace?

- Should we allow our system to hold back students who are ready to advance to new learning material?
- Should we advance students to new learning levels before they are ready?
- Should we consider the state-tested content areas as the most important, or consider all content areas equally important?

Crumley (2014) noted in Chugach's past traditional system, time (180 days per year) was the constant and learning (the amount learned by each student each year) was the variable. The new performance-based system allows students to decide the pace, making learning the constant, while time the variable.

Mooresville Graded School District in North Carolina is another school seeing positive results from personalized learning initiatives. In five years, the graduation rate has risen from 64% to 91% and the overall composite scores have risen from 63 to 88, which is third best in the state (Demski, 2012). Superintendent of Mooresville Mark Edwards said:

> Schools have no choice but to embrace a tech-enabled personalized learning model for education. It's a moral imperative. If we want our students to be able to find meaningful work and be contributing members of a global society, then we need to prepare them for their future, not our past (quoted in Demski, 2012).

Personalized education by its very name focuses on the individual needs of each student. While the concept of personalized education is not new, the amount of technology tools and resources available are. Schools striving for a personalized and individual learning environment must learn how to leverage the technology available and be open to new ways or organizing class time and physical space.

A Comparison of Traditional and Blended

Traditional instruction is teacher directed. Direct instruction usually includes the presentation of material, thinking aloud by the teacher, guided practice, correction and feedback, and modeling by the teacher (Kinney & Robertson, 2003). Further, the content presentation is linear since the instructor determines the order of the presentation of the content and students generally do not have the option of learning the content in a different order while in class (p. 320). Covering material takes precedence over teaching deeply and the teacher decides what, when, and how students should learn (Brown, 2003).

Compare this with what might take place in an enriched virtual blended classroom:

1. At the beginning of a learning unit, students are given a syllabus (Appendix C). The learning agreements are reviewed (Appendix E) and students are reminded of the expectations. The teacher may provide a brief overview of each topic covered in the unit. A pre-test might also be administered to assess what students already know. Students create goals and make a plan for the unit.
2. Class time is flexible depending on the model of blended learning. In the Enriched Virtual model of blended learning, students seldom meet face-to-face with their teachers every weekday. At the elementary level, a time for mathematics is most likely scheduled sometime during the day. During this time, students would start by checking the board or wiki for the "To Do" list.

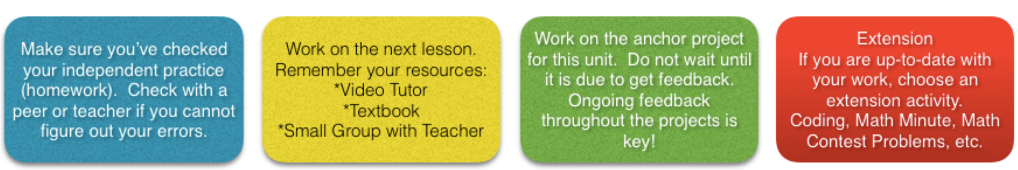


Figure 3: Math "To Do" List

3. Throughout the unit, the teacher schedules check-ins with students based on need. Goals and plans are monitored and adjusted based on each students' progress.
4. Students complete the required tasks on the syllabus and take the assessment when they are ready.

Traditional mathematics classrooms may utilize components found in a blended classroom. For example, an anchor project or extension might be assigned for each learning unit. Teachers might also use instructional videos to aid in content delivery. The main difference between a traditional and blended classroom is who directs the learning. In a traditional classroom, the teacher is the sole-decision maker and dictates the when, where, and how for all learning opportunities. In a blended classroom, the student has the majority of control.

While little research exists on blended learning, several programs are emerging across the K-12 sector. Horn and Staker (2012) use a blended-learning taxonomy (Figure 4 below) to depict a preliminary categorization scheme for the blended-learning landscape as it currently exists based on an analysis of programs that either are preparing to launch or are already in existence. Figure 4 shows four models of blended learning and Figure 5 provides the definition and example of each.

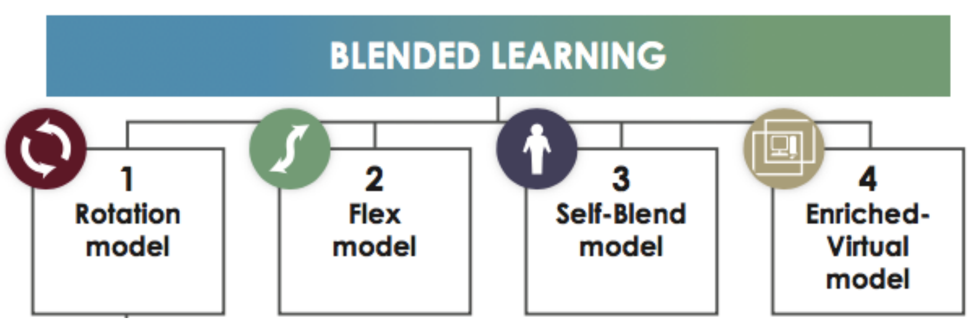


Figure 4: Blended-Learning Taxonomy
Horn & Staker (2012) Classifying k-12 blended learning

Blended-learning Model	Definition	Example
Station-Rotation Model	Students rotate on a fixed schedule or at the teacher's discretion among classroom-based learning modalities. The rotation includes at least one station for online learning. Other stations might include activities such as small-group or full-class instruction, group projects, individual tutoring, and pencil-and-paper assignments.	The KIPP LA Empower Academy equips each kindergarten classroom with 15 computers. The teacher rotates students among online learning, small-group instruction, and individual assignments.
Flex Model	The flex model is a program in which content and instruction are delivered primarily by the Internet, and students move on an individually customized, fluid schedule among learning modalities, and the teacher-of-record is on-site. The teacher-of-record or other adults provide face-to-face support on a flexible and adaptive as-needed basis through activities such as small-group instruction, group projects, and individual tutoring.	At San Francisco Flex Academy, the online-learning provider K12, Inc. delivers the curriculum and instruction, while face-to-face teachers use a data dashboard to offer targeted interventions and supplementation throughout the day for core courses.
Self-Blend Model	In this scenario, students choose to take one or more courses entirely online to supplement their traditional courses and the teacher-of-record is the online teacher. Students may take the online courses either on the brick-and-mortar campus or off site. It is not a whole-school experience.	Quakertown Community School District (QCSD) in Pennsylvania offers students in grades 6-12 the option of taking one or more online courses. Courses are asynchronous and students can work on them any time during the day. "Cyber lounges" allow space for students to work on their courses at school, but they are also free to complete the courses remotely if they prefer.
Enriched-Virtual Model	A whole-school experience in which students divide their time between attending a brick-and-mortar campus and learning remotely using online delivery of content and instruction. Students seldom attend the brick-and-mortar campus every weekday.	At the Albuquerque eCADEMY, students in grades 8-12 meet face to face with teachers for their first course meeting at a brick-and-mortar location. They can complete the rest of their coursework remotely, if they prefer, as long as they maintain at least a "C" grade point average in the program.

Figure 5: Blended-Learning Definitions and Examples
Adapted from Horn & Staker (2012) Classifying k-12 blended learning

Traditional and blended are not the only game players when it comes to math instruction. A key finding from the 2010 Symposium (Software & Information Industry Association, 2010) stated:

> Personalized learning cannot take place at scale without technology. Personalized learning is enabled by smart e-learning systems, which help dynamically tract and manage the learning needs of all students, and provide a platform to access myriad engaging learning content, resources and learning opportunities needed to meet each students needs everywhere at anytime, but which are not all available within the four walls of the traditional classroom (p. 6).

Several e-learning systems promise to personalize instruction for students. Some tools are free, yet others come with a yearly subscription cost. School districts and individual schools/classroom teachers are piloting and experimenting with some of these tools.

e-Learning System	Description
Dreambox: http://www.dreambox.com	According to the Dreambox Learning website, the journey to mathematical success can be achieved though Blended Learning and personalization. Several case studies are posted on their website, including the Carlton Innovation School in Massachusetts. Between the 2013 and 2014 Massachusetts Comprehensive Assessment System (MCAS) testing period, this school saw an increase of 17% in math proficiency school-wide through the use of Dreambox.
ALEKS Math: https://www.aleks.com	ALEKS stands for **A**ssessment and ***LE***arning in ***K***nowledge ***S***paces. Similar to other programs that promised a personalized math experience for learners, ALEKS uses adaptive questioning to determine what a student knows and does not know. ALEKS then instructs the student on the topics she is most ready to learn. According to the website, ALEKS provides the advantages of one-on-one instruction, 24/7, from virtually any Web-based computer for a fraction of the cost of a human tutor.

TenMarks: https://www.tenmarks.com	According to their website, TenMarks partners with teachers, schools and districts to drive an integrated model of curriculum and instruction, supported by technology and 1:1 personalization. The focus of TenMarks is learning, teaching, and sharing. Their vision is to create, curate, discover and share content with fellow educators while providing instructional resources to empower teacher with the rigor of the new math standards.
Khan Academy: https://www.khanacademy.org	Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom. According to the Khan website, "Our math missions guide learners from kindergarten to calculus using state-of-the-art, adaptive technology that identifies strengths and learning gaps." Summit San Jose in San Jose, California uses a blended model in math where 9^{th} graders spend part of each class working independently on Khan Academy. Summit San Jose was recognized in 2012 by FSG and the Michael & Susan Dell foundation publication as being one of the leading blended learning practitioners across the country.
Front Row: https://www.frontrowed.com	According to their website, Front Row is a program that accurately isolates skills and gaps with every student – then it fills the gaps and builds on the strengths, allowing students to grow into extraordinary mathematicians and readers. In an exploratory analysis of students' mathematics achievement after using Front Row, the findings support the hypothesis that Front Row improves students' mathematics outcomes.

Figure 6: eLearning Systems

Change is sometimes difficult, especially when there are such strong perceived norms in how mathematics should be taught. Piht and Eisenchidt (2008) have shown in their research that student's attitudes towards mathematics depends on the teaching methods and student's active participation in the learning process. Educators must work together and investigate new methods of mathematics instruction (Murray & Jorgensen, 2007). The blended model and online adaptive math programs are both relatively new methods that need a research base in order to make informed decisions moving forward.

Chapter 3

Methodology

If we knew what it was we were doing, it would not be called research, would it?
~Albert Einstein

Introduction

The purpose of this quasi-experimental study was to examine the performance of two different groups of sixth grade pre-algebra students in a suburban school district in Eastern Nebraska. The school district in this study has provided accelerated math options for sixth graders for the past twenty years. Throughout the years, the program has looked a variety of different ways from busing students to and from the middle school where sixth graders received instruction from a middle school teacher, to having a sixth grade teacher at various elementary schools teach the course. The number of students who qualify for the accelerated track has fluctuated over the years from less than ten students to over one hundred students. The strategy for delivering the course content has changed at least six times over the twenty-year period with teacher availability, space, and transportation being the major deciding factors.

The participant population includes 45, sixth graders from 8 different elementary schools taking pre-algebra. Fifteen of the students who qualified attended one elementary school in the district so it was decided that a sixth grade teacher at that school teach that group of students during the regularly scheduled math time (8:45-10:15 am), five days a week. This group is referred to as the traditional group in the study. The teacher of record was present at all times during class time and provided a structured process for delivering the content including taking notes, completing practice problems as a class, assigning homework that was corrected the following day, and administering a paper-pencil test at the end of each chapter. Although traditional in her delivery, the teacher of this group utilized various strategies and resources to engage students. Students watched video tutors provided by the textbook, worked in small groups to complete homework, and completed projects that assessed learning in alternative ways.

The other 30 students in the 2015-16 group representing 7 different elementary schools are referred to as the blended group in this study. For this group, the district decided that parents would drop students off at the middle school at 8:00 am each morning. Students attended class five days a week for forty-five minutes each day. This is referred to as teacher time. Afterwards, the district provided two buses that transported students back to their elementary school. Students had an additional 60-90 minutes of math time at their elementary school while their sixth grade peers took grade-level math. This is referred to as independent time. Due to the amount of time students had back in their elementary buildings, the teacher of record for this group relied heavily on technology resources to deliver content and assess understanding. For example, students were given a syllabus (Appendix D) at the beginning of each chapter to keep track of their progress. Instead of requiring all students to receive the same direct instruction from the teacher, students had a choice of working with a small group of peers, watching an online video tutor, or working in a small group with the teacher of record. When students returned to their school, they had additional tasks to complete during independent time, but had voice and choice on what they completed and where they worked. In most cases, students worked in the library, classroom, hallway, or other available space at the elementary buildings. Some students chose to work ahead in the chapter by watching videos and taking notes for upcoming sections, while others chose to take the 5-question quiz for each section that was provided by the textbook. Some students watched videos created by the teacher of record. These videos explained how to work out homework problems from the textbook. Still other students decided to work on their anchor project for the chapter. At the end of the learning unit, students were allowed to set their test date for the chapter depending on when they felt they were ready.

The sixth grade accelerated math program has looked a variety of ways since its inception twenty years ago. In an attempt to find a sustainable and cost-effective solution for this program, an enriched virtual model of blended learning was proposed for the 2016-17 school year. Twenty students from eight different elementary schools qualified to take pre-algebra. These students will remain in their respective elementary schools and will rely on their textbook and online resources for the majority of their instruction. The pre-algebra teacher will travel to each school on a rotation basis providing face-to-face instruction as well as individual assistance as needed. The gifted coordinator at each building will also serve as a facilitator in this program, checking in with students twice during a four-day rotation. This model comes with skepticism from parents and teachers alike, and rightfully so. It is a drastic difference in how mathematics has been taught for the past century. Blended learning is one method, yet limited rigorous research has been conducted on its effectiveness, particularly in K-12 school settings (Means et al., 2009). This study added to the research base and hopefully provides a starting point for how schools and districts might use blended learning more systematically.

Study Design

This study followed a quantitative methodology. It was quasi-experimental because the participants were not randomly assigned to groups. The study involved a posttest-only design, as well as a Likert-scale questionnaire. The posttest data included scores from 1) a cumulative final provided by the textbook, 2) a cumulative final written by district teachers, and 3) the Nebraska State Assessment (NeSA Mathematics). The Likert scale questionnaire measured students' perceptions about the importance of various teaching strategies and approaches to learning math.

The cumulative final provided by the textbook was published by Pearson to go along with the *Prentice Hall Mathematics Course 3* text. It is the cumulative test for chapters 1-12 and is intended to be comprehensive as well as cumulative. It consisted of 38 multiple-choice items (four choices) and assessed the range of concepts presented in the *Prentice Hall Mathematics Course 3* textbook. Students in both groups were given 90 minutes to complete the test and were allowed to use a calculator.

The cumulative final written by district teachers was also 38 questions. It is a cumulative test for chapters 1-12 and is also intended to be comprehensive as well as cumulative. It is not multiple choice and students were not allowed to use a calculator. Students were given 90 minutes to complete the test. Over the six-year course of using the *Prentice Hall Mathematics Course 3* textbook, teachers have taught additional material not covered in the book. A teacher written test allows for choice in what is assessed and level of complexity of the problems.

The Nebraska State Accountability-Mathematics (NeSA-M) is a statewide, mandated testing program that measures student achievement based on Nebraska's content standards. It consists of multiple-choice items in the core subject of mathematics. There are 24 questions, it is not timed, and calculators are not allowed. All questions are written and reviewed by Nebraska educators for content and sensitivity.

Creswell (2008) defines attitudinal questions as a group of questions related to obtaining individual attitudes or opinions from individuals (p. 397). The Likert-scale electronic questionnaire used in this study allowed for an easy, quick form of data collection on students' perceptions of teaching strategies and approaches to learning math. All students from both groups completed the questionnaire.

Description of Instruction Under Each Model

Traditional: Students attended class five days a week from 8:45-10:15 am with the instructor present at all times. The teacher utilized Google Classroom to disseminate syllabi and other assignments. She also assigned students to access online resources provided by the textbook including video tutors and online quizzes. Students were given a syllabus (Appendix D) of topics and homework assignments. Daily activities included checking the previous day's homework and answering questions, the teacher providing notes and practice problems on the new content, and the teacher assigning independent practice problems to be completed for the following day. At the end of the chapter, students took the paper-pencil test created by district teachers.

Blended: Students attend class five days a week from 8:00-8:45 am with the instructor present at all times. Students then returned to their elementary school where they had an additional 60-90 minutes of math time while their sixth grade peers were in math class. During this independent time, the pre-algebra teacher was not present. She uses a wiki (http://tinyurl.com/prealwms) so students knew exactly what was expected. Students watched videos online to prepare for the following day's lesson and completed homework and checked it by watching a teacher-created video. Other anchor projects were assigned for each chapter and students were also required to spend a certain amount of time on the Khan Academy pre-algebra course. At the beginning of the chapter, students were given a syllabus for the entire chapter (Appendix C). Students were able to work at their own pace to complete the tasks outlined on the syllabus, and had a choice in the sequence of completing the assigned tasks. When a student felt adequately prepared, they took the paper-pencil test created by district teachers.

The purpose of this study was to investigate the performance and experience of students enrolled in the two different learning environments: traditional and blended. The problem investigated was whether the type of learning environment impacted student achievement. This study compared achievement on a common year-end cumulative final provided by the textbook, a year-end cumulative final created by district teachers, and a common statewide examination. The study also utilized an electronic questionnaire to investigate students' perceptions on the importance of various teaching strategies and approaches to learning math.

Role of the Researcher

Researchers must identify their biases, values, and personal backgrounds that may shape their interpretations (Creswell, 2013). The researcher in this study was the teacher of record for the experimental group receiving the blended instruction. She and the control group teacher met and communicated on a consistent basis throughout the year to ensure both groups were receiving the same content. However, due to the nature of the experimental class only having 45 minutes a day with a teacher face-to-face, other tools and resources needed to be utilized so that all students in the study would be able to cover the content and finish the course at the same time.

Selection of the Participants

Criterion sampling was used for participant selection in this study. All students met the following criteria required by the district:

2. Their 5th grade Stanford Achievement Test (SAT 10) Math score was at the 95th percentile or greater
2. They scored in the 48th percentile or higher on the Orleans Hanna Algebra Prognosis Test
2. They scored 48 or higher on the Criterion Reference Test (CRT)

Due to the high population of students qualifying at one particular elementary school (15 students), the decision was made to have those students stay at their home school and receive instruction from one of the sixth grade teachers. This was the traditional group whose teacher instructed them using a traditional model. The remaining 30 students represented 7 different schools and received some daily face-to-face teacher instruction, as well as independent time back at their elementary school.

Instrumentation for Data Collection

To find a reason for differences between groups or individuals, researchers rely on measurements and statistics (Hoy, 2010). Four different data sets were collected for this quantitative study: 1) cumulative final provided by the textbook, b) cumulative final written by district teachers, c) NeSA-Math scores, and d) questionnaire results. Identity was protected when collecting data.

Cumulative Final Provided by the Textbook. The cumulative final provided by the textbook consisted of 38 questions and grades were reported as total number correct. Both teachers provided students with the exact same review guide and gave the same amount of time to take the test.

Cumulative Final Written by District Teachers. The cumulative final written by district teachers consisted of 38 questions and grades were reported as total number correct. The same teacher graded all 45 tests so there was consistency in points taken off. Both teachers provided students with the exact same review guide and gave the same amount of time to take the test.

NeSA Math. The Nebraska State Accountability-Mathematics (NeSA-M) is a statewide, mandated testing program that measures student achievement based on Nebraska's content standards. There are 58 multiple-choice items and performance is reported as Below the Standards, Meets the Standards, and Exceeds the Standards. All students were provided with the same practice tests before taking the test.

Questionnaire. The researcher developed the questionnaire. It was sent to ten middle school and high school math teachers in the district for feedback and input. The questionnaire had items related to preferred teaching strategies and preferences on ways to learn math (Appendix A). Some responses to the items on the questionnaire have a five-point Likert scale from 1=Not at all Important to 5=Extremely Important. Other responses use 1=Strongly Disagree to 5=Strongly Agree.

The request to conduct research and gather data was granted as long as the research results were submitted to the Assistant Superintendent of Teaching and Learning prior to publication. IRB Approval was obtained.

Methods

Quantitative data was collected for the study including grades and questionnaire data. In addition, course documents (qualitative) such as chapter syllabi, chapter projects, and questionnaire data were also collected.

The following research questions guided the research study:

1. How does the procedural knowledge of students in a traditional math course compare to students in a blended instruction format?
    a. Is there a difference in how the two groups perform on the end-of-course assessment provided by the textbook?
    b. Is there a difference in how the two groups perform on the end-of-course assessment written by district teachers?
    c. Does a significant difference exist in how the two groups perform on the Nebraska State Assessment (NeSA-Mathematics)?

In order to answer these research questions, the scores on the end-of-course cumulative assessments from both participant groups were analyzed using an unpaired t-test. The NeSA Math results were also analyzed in this manner.

2. What are sixth grade pre-algebra students' preferences when it comes to teaching strategies and approaches to learning in math?

For this research question, an online survey was given to students in both population groups. Students completed the survey during their mathematics class. The survey was administered electronically via Google Forms and students completed it on their school issued iPad.

Data Analysis

Data analysis was conducted using the online GraphPad software at http://www.graphpad.com/quickcalcs/ttest1.cfm. Data was entered and coded appropriately, making sure student names are not used. An unpaired sample *t*-test was used to determine if there is a significant difference in procedural knowledge between the traditional and blended group.

Chapter 4

Findings

The scientific man does not aim at an immediate result. He does not expect that his advanced ideas will be readily taken up…His duty is to lay the foundation for those who are to come, and point the way. ~Nikola Tesla

Introduction

This quasi-experimental study examined the performance of two different groups of sixth grade pre-algebra students in a suburban school district in Eastern Nebraska. The study included 45, sixth graders from 8 different elementary schools taking pre-algebra, which is a 2-year acceleration from their age-level peers. The presentation of the data analysis is organized according to the three research questions.

Research Question One: How does the procedural knowledge of students in a traditional math course compare to students in a blended instruction format?

A. Is there a difference in how the two groups perform on the end-of-course cumulative assessment provided by the textbook?

B. Is there a difference in how the two groups perform on the end-of-course cumulative assessment written by district teachers?

C. Does a significant difference exist in how the two groups perform on the Nebraska State Assessment (NeSA Math)?

The unpaired t-test was utilized to compare the means of the blended and traditional groups for each sub question.

Sub Question A: In the spring semester, 96 percent of the students (*N* =43) completed the end-of-course cumulative assessment provided by the textbook. Table 1 shows the blended mean is 85.25 with a standard deviation of 6.74. The traditional mean is 87.80 with a standard deviation of 5.77. The two-tailed P value equals 0.2218 and by conventional criteria, the difference is considered to be not statistically significant.

Table 1

End-Of-Course Cumulative Assessment: Textbook

Between Groups Comparison

	Blended Group *N* = 28		Traditional Group *N* = 15			
Source of Data	*M*	*(SD)*	*M*	*(SD)*	*t*	*p*
End-of-Course Cumulative Assessment: (Textbook)	85.25	(6.74)	87.80	(5.77)	1.2407	0.2218

Not statistically significant (two-tailed); df = 41

Sub Question B: In the spring semester, 93 percent of the students (*N* =42) completed the end-of-course cumulative assessment written by district teachers. Table 2 shows the blended mean is 81.71 with a standard deviation of 9.79. The traditional mean is 79.00 with a standard deviation of 11.95. The two-tailed P value equals 0.4360 and by conventional criteria, the difference is considered to be not statistically significant.

Table 2

End-Of-Course Cumulative Assessment: Teacher Written

Between Groups Comparison

	Blended Group *N* = 28		Traditional Group *N* = 14			
Source of Data	*M*	*(SD)*	*M*	*(SD)*	*t*	*p*
End-of-Course Cumulative Assessment: Teacher Written	81.71	(9.79)	79.00	(11.95)	0.7869	0.4360

Not statistically significant (two-tailed); df = 40

Sub Question C: In the spring semester, 98 percent of the students (*N* =44) completed the Nebraska State Assessment (NeSA Math). Table 3 shows the blended mean is 55.07 with a standard deviation of 2.17. The traditional mean is 54.93 with a standard deviation of 2.49. The two-tailed P value equals 0.8527 and by conventional criteria, the difference is considered to be not statistically significant.

Table 3

Nebraska State Assessment: NeSA-Mathematics

Between Groups Comparison

	Blended Group *N* = 29		Traditional Group *N* = 15			
Source of Data	*M*	*(SD)*	*M*	*(SD)*	*t*	*p*
Nebraska State Assessment: NeSA-Mathematics	55.07	(2.17)	54.93	(2.49)	0.1868	0.8527

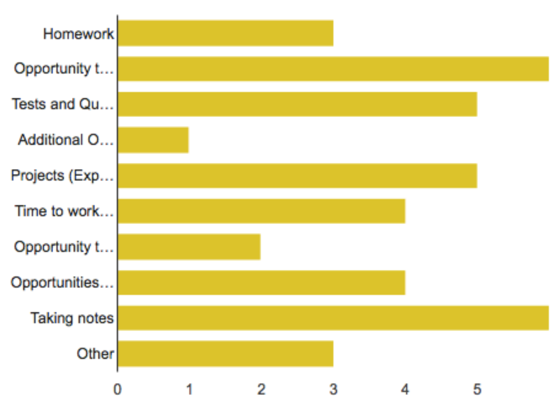
Not statistically significant (two-tailed); df = 42

Research Question Two: What are sixth grade pre-algebra students' preferences when it comes to teaching strategies in math and approaches to learning?

In the spring semester, 100% of the students (N =30) in the blended class and 87 percent of the students (N =13) in the traditional class completed the Student Math Questionnaire (Appendix A).

Table 4: Traditional Group Responses

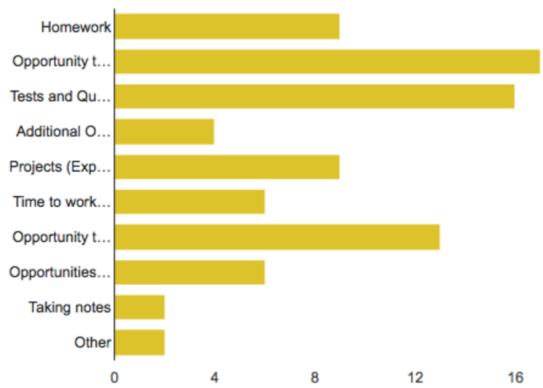
Which criteria are most important for your pre-algebra experience? Pick 3.



Homework	3	23.1%
Opportunity to work at own pace	6	46.2%
Tests and Quizzes	5	38.5%
Additional Online Resources (videos, quizzes, wiki, etc.)	1	7.7%
Projects (Explain Everything, Indirect Measurement Project, etc.)	5	38.5%
Time to work individually with the teacher	4	30.8%
Opportunity to make test corrections	2	15.4%
Opportunities for problem solving (problem solving packet, logic puzzle packet, math analogies packet, Zacarro math packet, etc.)	4	30.8%
Taking notes	6	46.2%
Other	3	23.1%

Table 5: Blended Group Responses

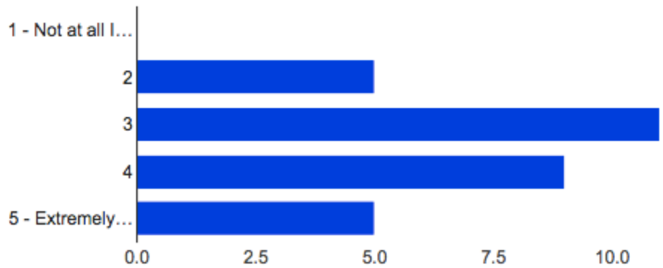
Which criteria are most important for your pre-algebra experience? Pick 3.



Homework	**9**	32.1%
Opportunity to work at own pace	**17**	60.7%
Tests and Quizzes	**16**	57.1%
Additional Online Resources (videos, quizzes, wiki, etc.)	**4**	14.3%
Projects (Explain Everything, Indirect Measurement Project, etc.)	**9**	32.1%
Time to work individually with the teacher	**6**	21.4%
Opportunity to make test corrections	**13**	46.4%
Opportunities for problem solving (problem solving packet, logic puzzle packet, math analogies packet, Zacarro math packet, etc.)	**6**	21.4%
Taking notes	**2**	7.1%
Other	**2**	7.1%

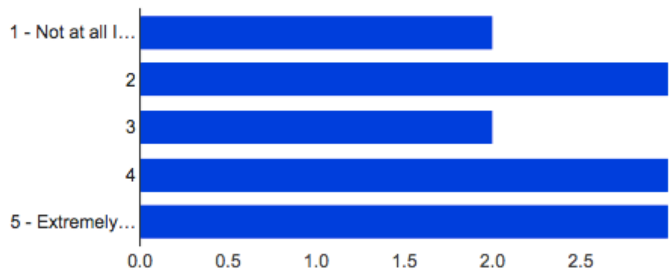
Questionnaire Item 1: Taking a pre-test before each chapter to see what I already know about the topic [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	5	16.7%
3	11	36.7%
4	9	30%
5 - Extremely Important	5	16.7%

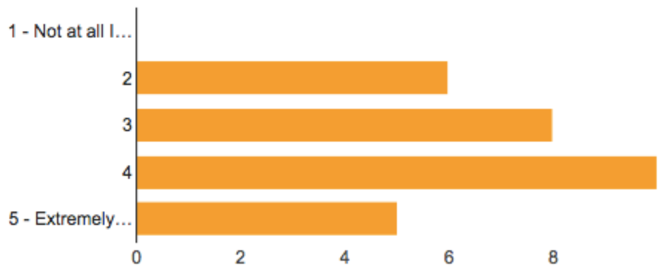
Traditional



1 - Not at all Important	2	15.4%
2	3	23.1%
3	2	15.4%
4	3	23.1%
5 - Extremely Important	3	23.1%

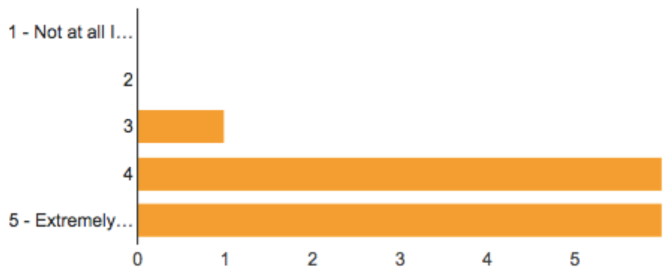
Questionnaire Item 2: Providing situations where the math topic/concept is used outside of math class [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	6	20.7%
3	8	27.6%
4	10	34.5%
5 - Extremely Important	5	17.2%

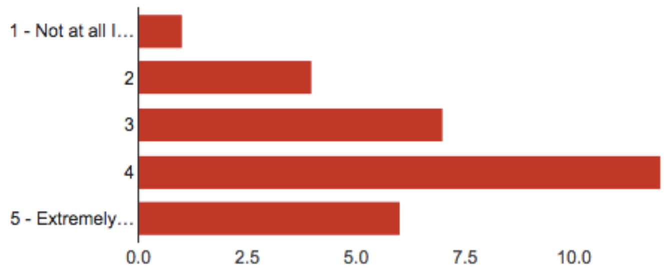
Traditional



1 - Not at all Important	0	0%
2	0	0%
3	1	7.7%
4	6	46.2%
5 - Extremely Important	6	46.2%

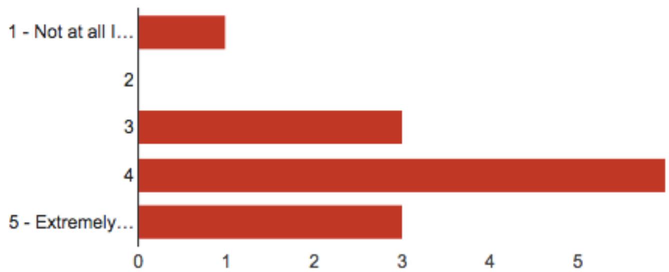
Questionnaire Item 3: Covering one topic/lesson in the textbook each day [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**1**	3.3%
2	**4**	13.3%
3	**7**	23.3%
4	**12**	40%
5 - Extremely Important	**6**	20%

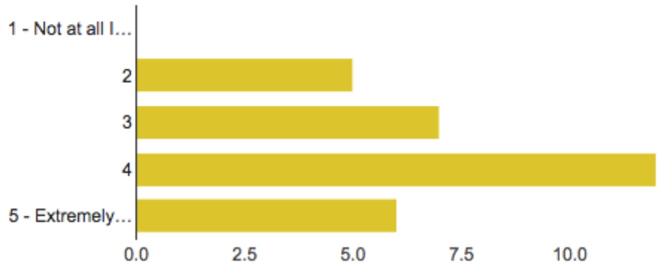
Traditional



1 - Not at all Important	**1**	7.7%
2	**0**	0%
3	**3**	23.1%
4	**6**	46.2%
5 - Extremely Important	**3**	23.1%

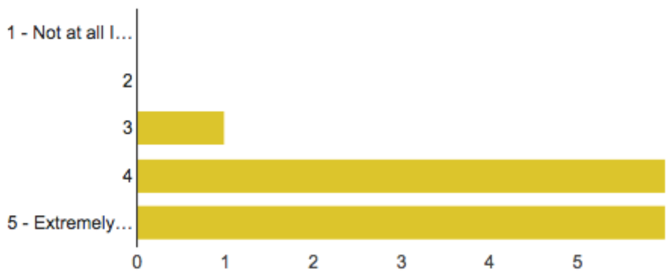
Questionnaire Item 4: Taking notes and completing practice problems in class with the teacher [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	5	16.7%
3	7	23.3%
4	12	40%
5 - Extremely Important	6	20%

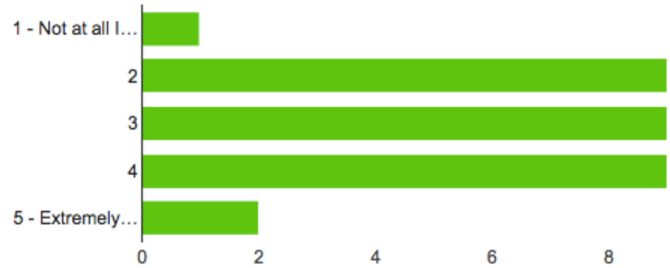
Traditional



1 - Not at all Important	0	0%
2	0	0%
3	1	7.7%
4	6	46.2%
5 - Extremely Important	6	46.2%

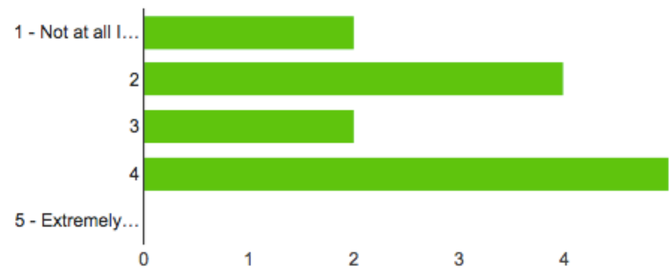
Questionnaire Item 5: Taking notes and completing practice problems from a video [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	1	3.3%
2	9	30%
3	9	30%
4	9	30%
5 - Extremely Important	2	6.7%

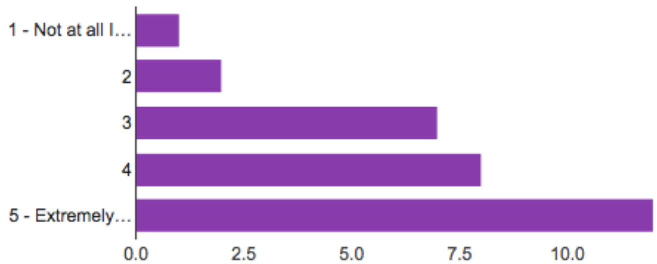
Traditional



1 - Not at all Important	2	15.4%
2	4	30.8%
3	2	15.4%
4	5	38.5%
5 - Extremely Important	0	0%

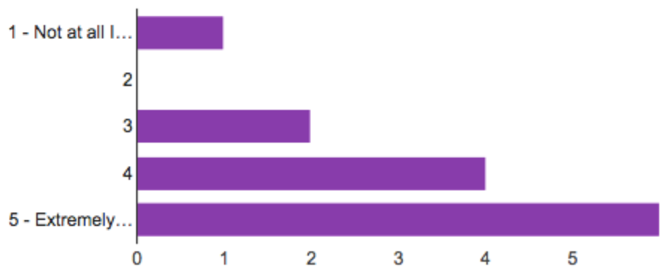
Questionnaire Item 6: Checking homework in class with the teacher [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**1**	3.3%
2	**2**	6.7%
3	**7**	23.3%
4	**8**	26.7%
5 - Extremely Important	**12**	40%

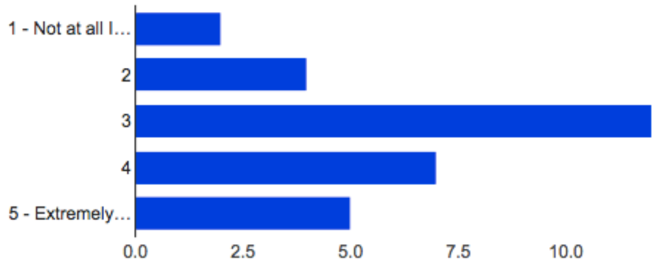
Traditional



1 - Not at all Important	**1**	7.7%
2	**0**	0%
3	**2**	15.4%
4	**4**	30.8%
5 - Extremely Important	**6**	46.2%

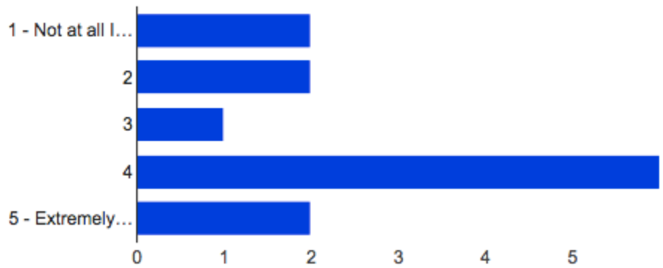
Questionnaire Item 7: Checking homework online with the opportunity to ask the teacher questions on problems missed [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**2**	6.7%
2	**4**	13.3%
3	**12**	40%
4	**7**	23.3%
5 - Extremely Important	**5**	16.7%

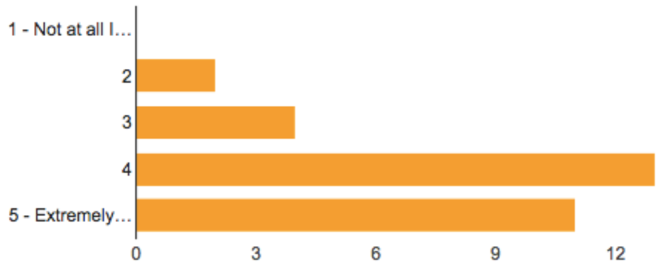
Traditional



1 - Not at all Important	**2**	15.4%
2	**2**	15.4%
3	**1**	7.7%
4	**6**	46.2%
5 - Extremely Important	**2**	15.4%

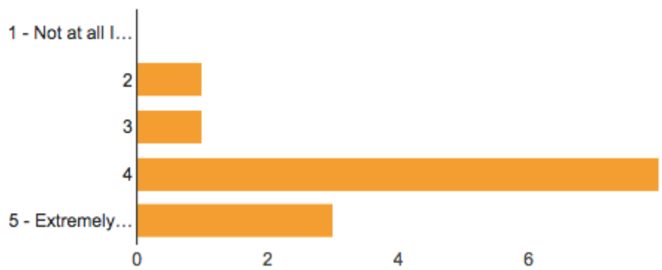
Questionnaire Item 8: Providing multiple methods for solving the same type of problem [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**2**	6.7%
3	**4**	13.3%
4	**13**	43.3%
5 - Extremely Important	**11**	36.7%

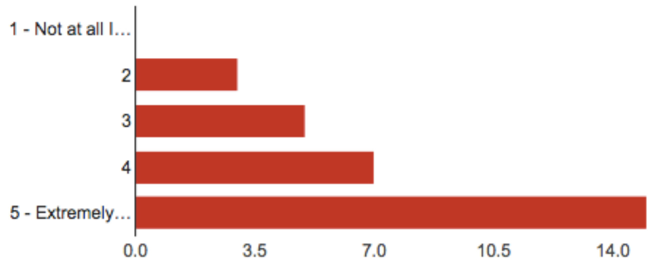
Traditional



1 - Not at all Important	**0**	0%
2	**1**	7.7%
3	**1**	7.7%
4	**8**	61.5%
5 - Extremely Important	**3**	23.1%

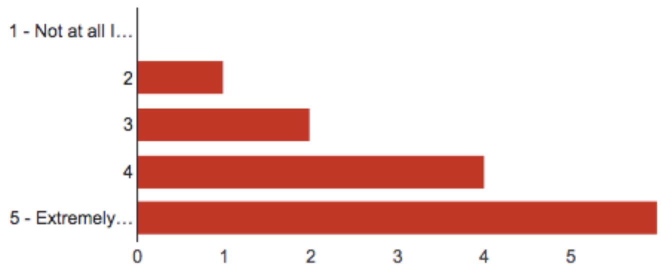
Questionnaire Item 9: Attending class 5 days a week for a set amount of time with a teacher present at all times [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**3**	10%
3	**5**	16.7%
4	**7**	23.3%
5 - Extremely Important	**15**	50%

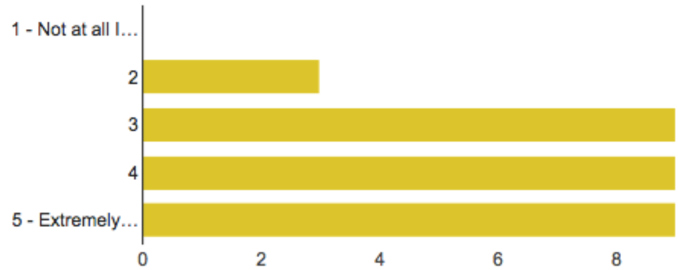
Traditional



1 - Not at all Important	**0**	0%
2	**1**	7.7%
3	**2**	15.4%
4	**4**	30.8%
5 - Extremely Important	**6**	46.2%

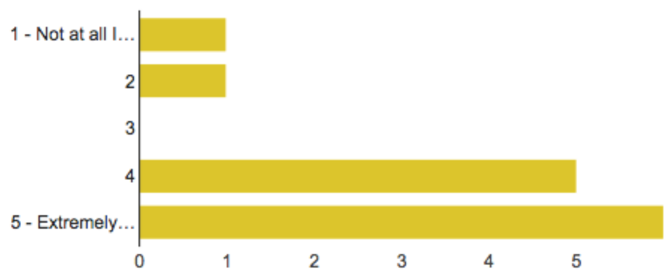
Questionnaire Item 10: Assigning projects that allow you to demonstrate your knowledge of math concepts in alternative ways [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	3	10%
3	9	30%
4	9	30%
5 - Extremely Important	9	30%

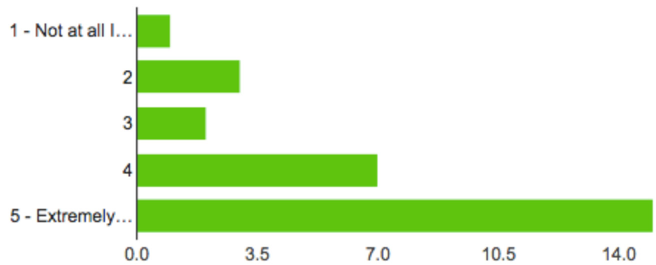
Traditional



1 - Not at all Important	1	7.7%
2	1	7.7%
3	0	0%
4	5	38.5%
5 - Extremely Important	6	46.2%

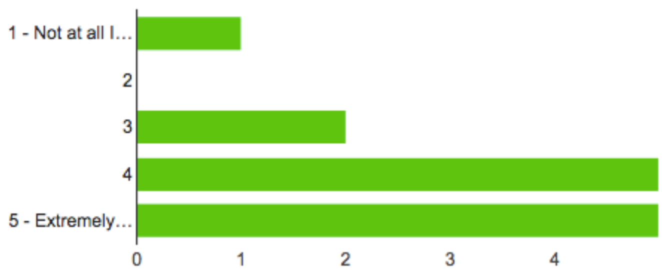
Questionnaire Item 11: Working at your own pace (i.e. completing multiple lessons in one day, taking the test when ready as opposed to when the rest of the class is ready, etc.). [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	1	3.6%
2	3	10.7%
3	2	7.1%
4	7	25%
5 - Extremely Important	15	53.6%

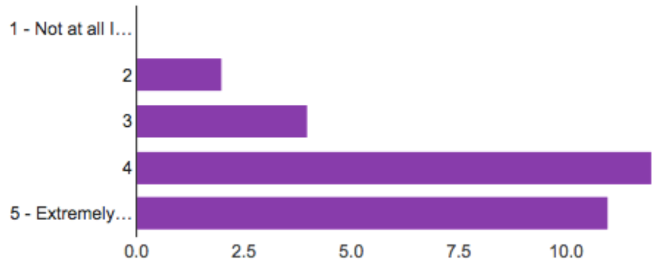
Traditional



1 - Not at all Important	1	7.7%
2	0	0%
3	2	15.4%
4	5	38.5%
5 - Extremely Important	5	38.5%

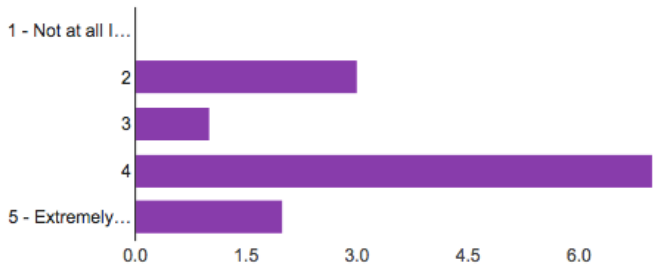
Questionnaire Item 12: Using tools and programs (i.e. iPads, computers, spreadsheets, apps, graphing calculators, etc.) to explore math concepts [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**2**	6.9%
3	**4**	13.8%
4	**12**	41.4%
5 - Extremely Important	**11**	37.9%

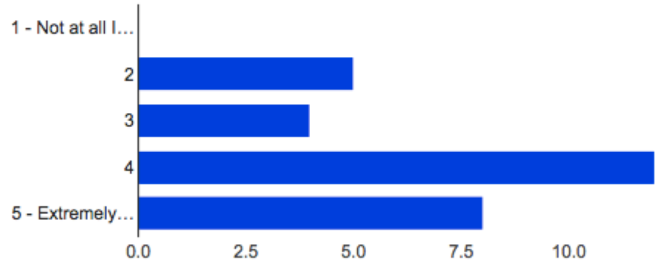
Traditional



1 - Not at all Important	**0**	0%
2	**3**	23.1%
3	**1**	7.7%
4	**7**	53.8%
5 - Extremely Important	**2**	15.4%

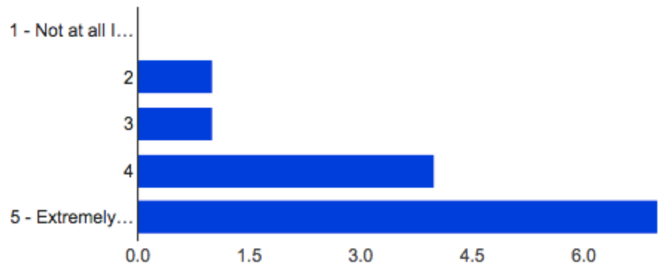
Questionnaire Item 13: Having the ability to work with the teacher one-on-one or in a small group [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**5**	17.2%
3	**4**	13.8%
4	**12**	41.4%
5 - Extremely Important	**8**	27.6%

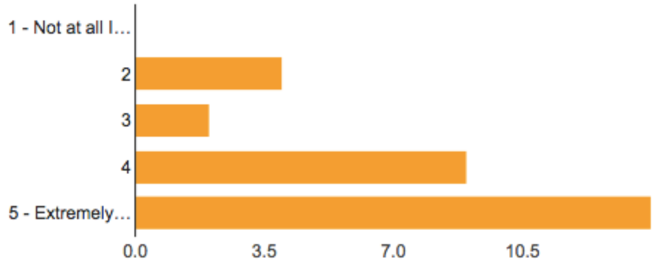
Traditional



1 - Not at all Important	**0**	0%
2	**1**	7.7%
3	**1**	7.7%
4	**4**	30.8%
5 - Extremely Important	**7**	53.8%

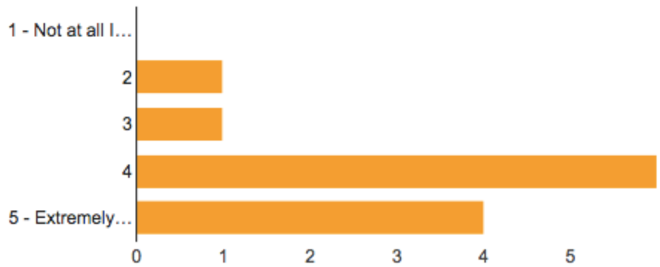
Questionnaire Item 14: Assessing learning with quizzes and tests [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**4**	13.8%
3	**2**	6.9%
4	**9**	31%
5 - Extremely Important	**14**	48.3%

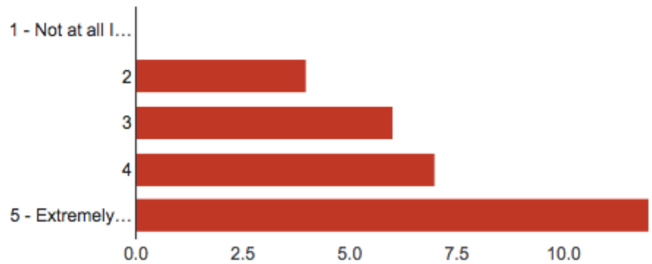
Traditional



1 - Not at all Important	**0**	0%
2	**1**	8.3%
3	**1**	8.3%
4	**6**	50%
5 - Extremely Important	**4**	33.3%

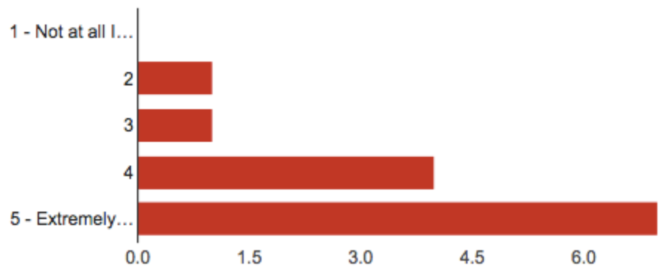
Questionnaire Item 15: Working with a partner or a small group on problem solving activities [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**4**	13.8%
3	**6**	20.7%
4	**7**	24.1%
5 - Extremely Important	**12**	41.4%

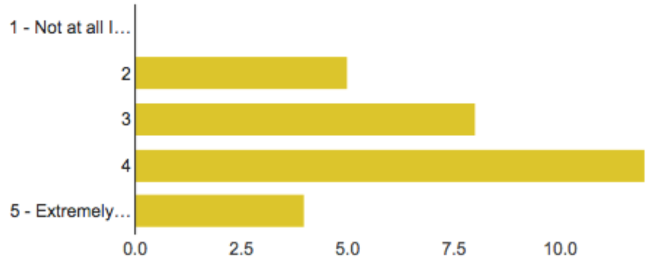
Traditional



1 - Not at all Important	**0**	0%
2	**1**	7.7%
3	**1**	7.7%
4	**4**	30.8%
5 - Extremely Important	**7**	53.8%

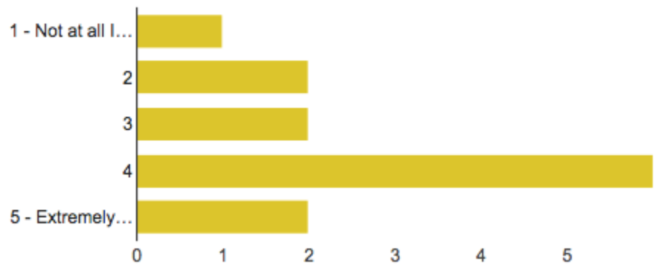
Questionnaire Item 16: Being able to communicate using mathematical vocabulary [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**0**	0%
2	**5**	17.2%
3	**8**	27.6%
4	**12**	41.4%
5 - Extremely Important	**4**	13.8%

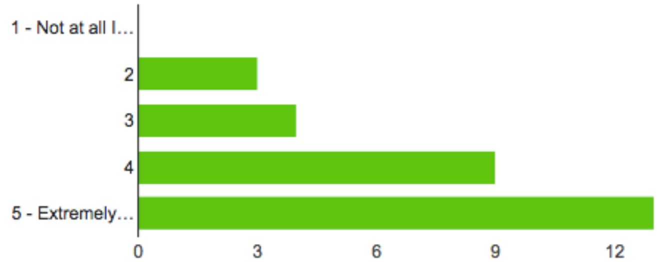
Traditional



1 - Not at all Important	**1**	7.7%
2	**2**	15.4%
3	**2**	15.4%
4	**6**	46.2%
5 - Extremely Important	**2**	15.4%

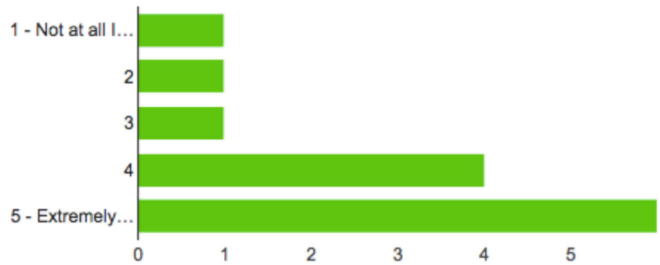
Questionnaire Item 17: Completing homework on a daily basis [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	3	10.3%
3	4	13.8%
4	9	31%
5 - Extremely Important	13	44.8%

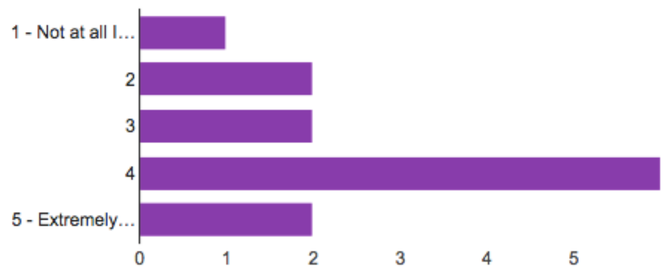
Traditional



1 - Not at all Important	1	7.7%
2	1	7.7%
3	1	7.7%
4	4	30.8%
5 - Extremely Important	6	46.2%

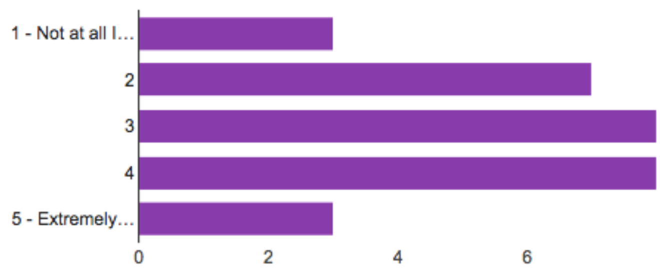
Questionnaire Item 18: Following the sequence of topics from a textbook [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	**1**	7.7%
2	**2**	15.4%
3	**2**	15.4%
4	**6**	46.2%
5 - Extremely Important	**2**	15.4%

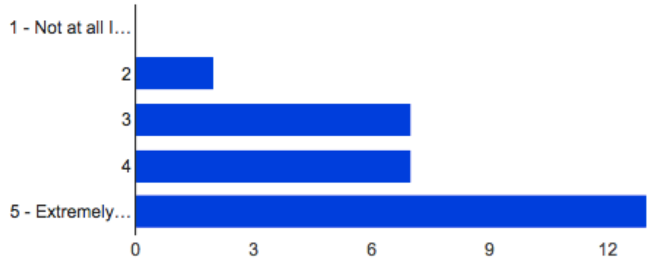
Traditional



1 - Not at all Important	**3**	10.3%
2	**7**	24.1%
3	**8**	27.6%
4	**8**	27.6%
5 - Extremely Important	**3**	10.3%

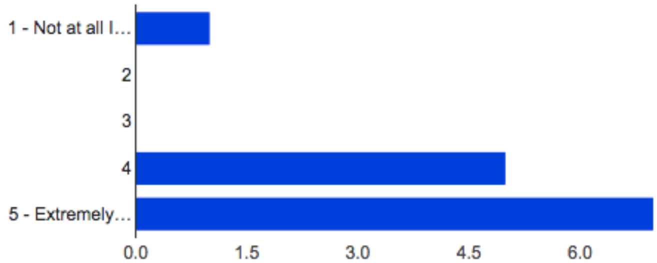
Questionnaire Item 19: Learning to work independently and take ownership of learning [Please rate the importance of each criteria for your pre-algebra experience.]

Blended



1 - Not at all Important	0	0%
2	2	6.9%
3	7	24.1%
4	7	24.1%
5 - Extremely Important	13	44.8%

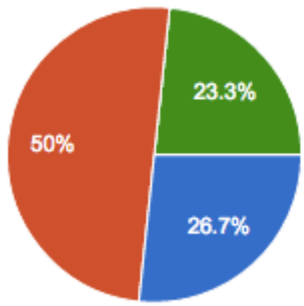
Traditional



1 - Not at all Important	1	7.7%
2	0	0%
3	0	0%
4	5	38.5%
5 - Extremely Important	7	53.8%

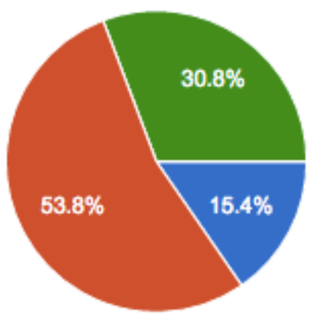
Questionnaire Item 20: How much nightly homework do you think you should have in pre-algebra?

Blended



0-20 minutes	8	26.7%
21-40 minutes	15	50%
41-60 minutes	0	0%
Other	7	23.3%

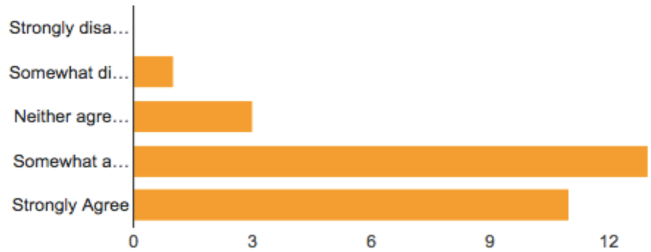
Traditional



0-20 minutes	2	15.4%
21-40 minutes	7	53.8%
41-60 minutes	0	0%
Other	4	30.8%

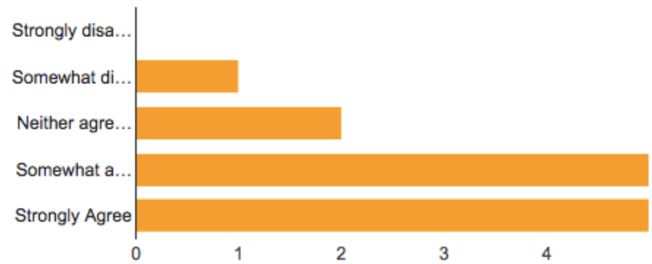
Questionnaire Item 21: I need to attend math class 5 times a week for a set amount of time each day in order to be successful [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	0	0%
Somewhat disagree	1	3.6%
Neither agree nor disagree	3	10.7%
Somewhat agree	13	46.4%
Strongly Agree	11	39.3%

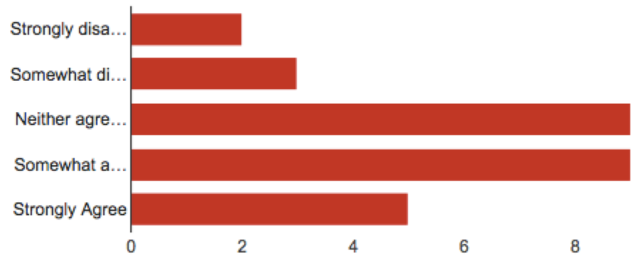
Traditional



Strongly disagree	0	0%
Somewhat disagree	1	7.7%
Neither agree nor disagree	2	15.4%
Somewhat agree	5	38.5%
Strongly Agree	5	38.5%

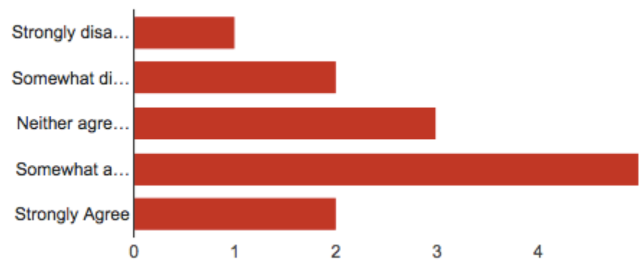
Questionnaire Item 22: I need daily homework in math [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	2	7.1%
Somewhat disagree	3	10.7%
Neither agree nor disagree	9	32.1%
Somewhat agree	9	32.1%
Strongly Agree	5	17.9%

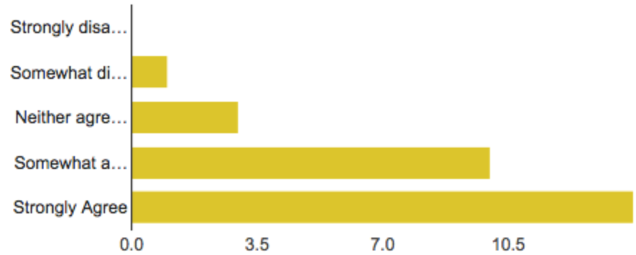
Traditional



Strongly disagree	1	7.7%
Somewhat disagree	2	15.4%
Neither agree nor disagree	3	23.1%
Somewhat agree	5	38.5%
Strongly Agree	2	15.4%

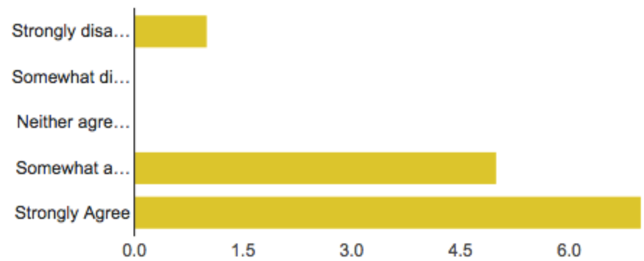
Questionnaire Item 23: I want to take ownership of my learning [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	0	0%
Somewhat disagree	1	3.6%
Neither agree nor disagree	3	10.7%
Somewhat agree	10	35.7%
Strongly Agree	14	50%

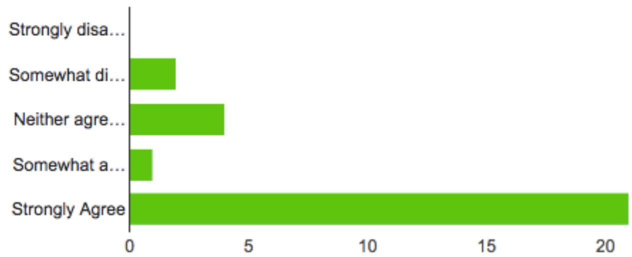
Traditional



Strongly disagree	1	7.7%
Somewhat disagree	0	0%
Neither agree nor disagree	0	0%
Somewhat agree	5	38.5%
Strongly Agree	7	53.8%

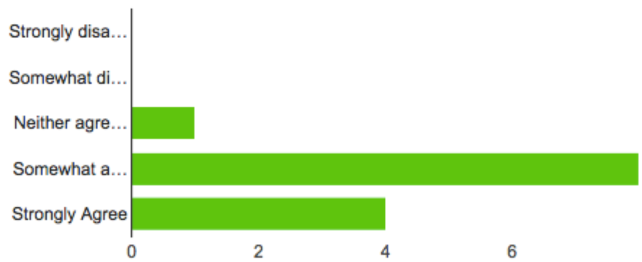
Questionnaire Item 24: I am appropriately challenged in pre-algebra [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	0	0%
Somewhat disagree	2	7.1%
Neither agree nor disagree	4	14.3%
Somewhat agree	1	3.6%
Strongly Agree	21	75%

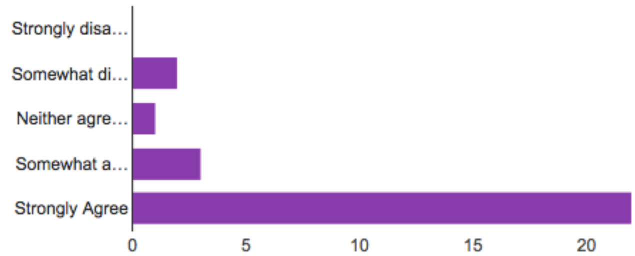
Traditional



Strongly disagree	0	0%
Somewhat disagree	0	0%
Neither agree nor disagree	1	7.7%
Somewhat agree	8	61.5%
Strongly Agree	4	30.8%

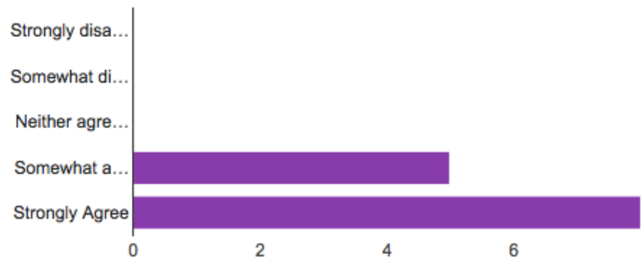
Questionnaire Item 25: During pre-algebra this year, I have grown in my mathematical ability and confidence [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	0	0%
Somewhat disagree	2	7.1%
Neither agree nor disagree	1	3.6%
Somewhat agree	3	10.7%
Strongly Agree	22	78.6%

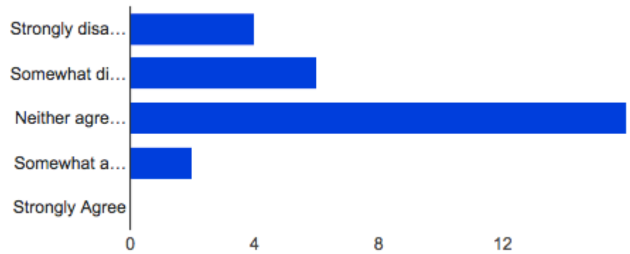
Traditional



Strongly disagree	0	0%
Somewhat disagree	0	0%
Neither agree nor disagree	0	0%
Somewhat agree	5	38.5%
Strongly Agree	8	61.5%

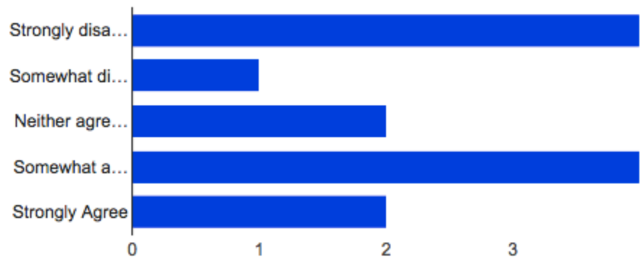
Questionnaire Item 26: I should be taught math the same way my parents were taught math [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	4	14.3%
Somewhat disagree	6	21.4%
Neither agree nor disagree	16	57.1%
Somewhat agree	2	7.1%
Strongly Agree	0	0%

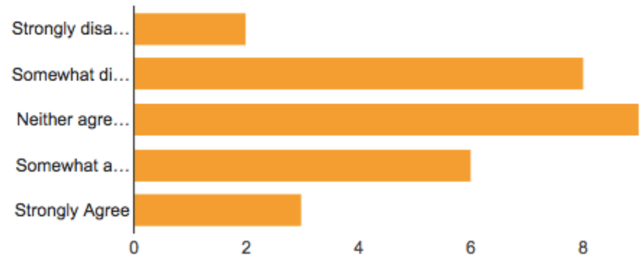
Traditional



Strongly disagree	4	30.8%
Somewhat disagree	1	7.7%
Neither agree nor disagree	2	15.4%
Somewhat agree	4	30.8%
Strongly Agree	2	15.4%

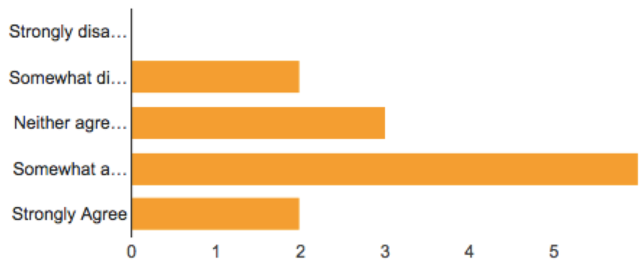
Questionnaire Item 27: The teacher should be the one solely responsible for teaching math content [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	2	7.1%
Somewhat disagree	8	28.6%
Neither agree nor disagree	9	32.1%
Somewhat agree	6	21.4%
Strongly Agree	3	10.7%

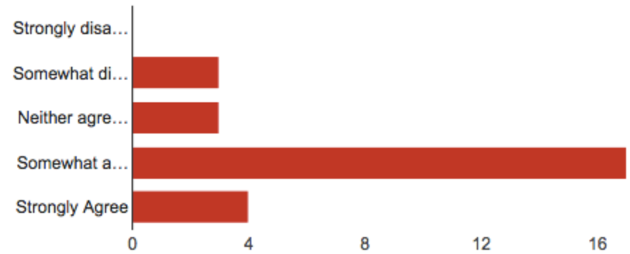
Traditional



Strongly disagree	0	0%
Somewhat disagree	2	15.4%
Neither agree nor disagree	3	23.1%
Somewhat agree	6	46.2%
Strongly Agree	2	15.4%

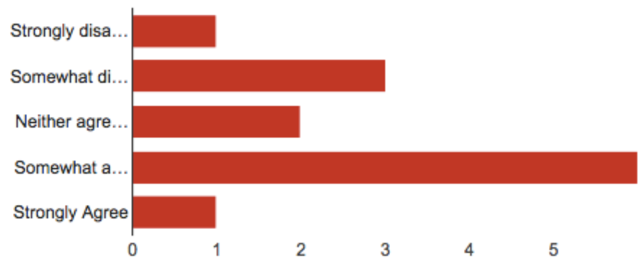
Questionnaire Item 28: If given the correct tools, I could teach myself math concepts [For each of the statements below, please select the extent to which you agree or disagree.]

Blended



Strongly disagree	0	0%
Somewhat disagree	3	11.1%
Neither agree nor disagree	3	11.1%
Somewhat agree	17	63%
Strongly Agree	4	14.8%

Traditional



Strongly disagree	1	7.7%
Somewhat disagree	3	23.1%
Neither agree nor disagree	2	15.4%
Somewhat agree	6	46.2%
Strongly Agree	1	7.7%

Chapter 5

Conclusions and Discussion of Findings

Research consists in seeing what everyone else has seen, but thinking what no one else has thought. ~Albert Szent-Gyorgyi

The overriding purpose of this quasi-experimental study was to determine if any differences existed in the procedural knowledge of two different groups of sixth grade pre-algebra students. Students' preferences of teaching strategies and approaches to learning math were also collected. Forty-five, sixth graders participated in the study and represented two different groups: traditional and blended. In order to examine the performance of the groups, two cumulative end-of-book assessments were given, as well as the Nebraska State Accountability Mathematics Test (NeSA-Math). Student preferences of teaching strategies and approaches to learning math were collected through an electronic questionnaire. This chapter reports the conclusions related to the study's research questions and discussion on findings.

Conclusions

Research question one addressed any differences that existed in the procedural knowledge of students between the two groups. The comparison of groups in all three assessments was determined to be not statistically significant.

- For the cumulative assessment provided by textbook, the traditional mean was 87.80 with a standard deviation of 5.77. The blended mean was 85.25 with a standard deviation of 6.74. The two-tailed P value equals 0.2218 and by conventional criteria, the difference was considered to be not statistically significant.

- For the cumulative assessment written by district teachers, the traditional mean was 79.00 with a standard deviation of 11.95. The blended mean was 81.71 with a standard deviation of 9.79. The two-tailed P value equals 0.4360 and by conventional criteria, the difference was considered to be not statistically significant.
- For the Nebraska State Assessment (NeSA Math), the traditional mean was 54.93 with a standard deviation of 2.49. The blended mean was 55.07 with a standard deviation of 2.17. The two-tailed P value equals 0.8527 and by conventional criteria, the difference was considered to be not statistically significant.

Research question two addressed students' preferences in teaching strategies and approaches to learning math. Figure 7 shows the top ranked criteria for each group from one questionnaire item and Figure 8 shows the total percentage from both groups selecting important or extremely important for each criterion. Figure 9 shows the total percentage from both groups selecting somewhat agree or strongly agree to statements related to their pre-algebra experience.

Traditional	**Blended**
• Working at own pace (46%) • Taking notes (46%) • Taking tests and quizzes (39%) • Projects (39%)	• Working at own pace (61%) • Tests and quizzes (57%) • Test corrections (46%)

Figure 7: Most Important Criteria for Each Group

Criterion	Percent
Providing multiple methods for solving the same type of problem	81%
Assessing learning with quizzes and tests	80%
Working at your own pace (i.e. completing multiple lessons in one day, taking the test when ready as opposed to when the rest of the class is ready, etc.)	78%
Learning to work independently and take ownership of learning	76%
Using tools and programs (i.e. iPads, computers, spreadsheets, apps, graphing calculators, etc.) to explore math concepts	76%
Attending class 5 days a week for a set amount of time with a teacher present at all times	74%
Completing homework on a daily basis	76%
Having the ability to work with the teacher one-on-one or in a small group	74%
Working with a partner or a small group on problem solving activities	71%
Taking notes and completing practice problems in class with the teacher	70%
Checking homework in class with the teacher	70%
Assigning projects that allow you to demonstrate your knowledge of math concepts in alternative ways	67%
Providing situations where there the math topic/concept is used outside of math class	64%
Covering one topic/lesson in the textbook each day	63%
Being able to communicate using mathematical vocabulary	57%
Taking a pre-test before each chapter to see what I already know about the topic	47%
Checking homework online with the opportunity to ask the teacher questions on problems missed	47%
Taking notes and completing practice problems from a video	37%

Figure 8: Important Criteria for Pre-Algebra Experience

Statement	Percent
During pre-algebra this year, I have grown in my mathematical ability and confidence	93%
I want to take ownership of my learning	88%
I need to attend math class 5 times a week for a set amount of time each day in order to be successful	83%
I am appropriately challenged in pre algebra	83%
If given the correct tools, I could teach myself math concepts	70%
I need daily homework in math	51%
The teacher should be the one solely responsible for teaching math content	41%
I should be taught math the same way my parents were taught math	15%

Table 9: Statements About Pre-Algebra Experience

Discussion of Findings

The results of this study supported the use of different instructional models, teaching strategies, and approaches to learning math. While it cannot be concluded that one model of instruction (traditional or blended) was better than the other, not finding a significant difference in students' procedural knowledge on the three assessments suggests the need for further investigation. Students' preferences in teaching strategies and approaches to learning math may change based on age and level of math being studied, however it is important for schools to consider if they want to support individual learning needs and increase engagement. Although this study was limited to a single district, grade-level, and subject matter, it is indicative of the changing educational landscapes of the 21st century and presents implications for practice, instructional change, and for further research.

Implications for practice. Universal Design for Learning (UDL) is a set of principles that informs and guides work in educational research and development (About Universal Design for Learning, 2015). According to the cast.org website:

> As part of its mission to bust all barriers to learning, CAST researches and develops innovative solutions to make education more inclusive and effective. We do so by applying the principles of Universal Design for Learning, a framework rooted in the learning sciences (2015).

Schools are often forced to standardize what they teach and assess, but this standardization often clashes with the need for personalization in education. While the "what is taught" and "how it is assessed" may not be open for discussion and change, Bray and McClaskey (2015) say the use of UDL principles can assist teachers in planning universally designed lessons that can reduce barriers to learning, as well as optimize levels of challenge and support, to meet the needs of all learners from the start (p. 55). In this study, changing the model of instruction in and of itself didn't have a significant impact on students' performance on three assessments. However, real significance will occur when all stakeholders in a district and community come together and support personalization and how it impacts student learning. To introduce personalization, schools need to move away from the monolithic instruction of batches of students toward a modular, student-centric approach (Christiansen, Horn, & Johnson, 2008). One way to accomplish this is to consider students' preferences in learning and approaches to learning.

John Hattie identified six major sources of variance in student's achievement including students, home, schools, principals, peer effects, and teachers (Hattie, 2003).

Eighty percent of the variance alone comes from students (50%) and teachers (30%) and Hattie suggests the focus should be placed on the greatest source of variance that can make the difference – the teacher (p. 3). In order to further analyze students' responses on the questionnaire about preferences in teaching strategies and approaches to learning, the questions were sorted according to Hattie's data collection on the effect size of various influences. The percentage shows the number of students from both groups that marked a 4 or 5 for each criterion (1-not at all important and 5-extremely important) or somewhat or strongly agreed with the statement.

Influence	Effect Size	Explanation of Influence	Questionnaire Item(s)	% of Students
Feedback	1.13	Using formative assessments to inform instruction and providing feedback that is immediate, and flows from student to teacher as well as teacher to student	10 14	67% 80%
Direct Instruction	0.82	Not to be confused with didactic teacher-led talking from the front. Refers to 7 major steps: 1. Teacher specifies learning outcomes/intentions 2. Teacher knows and communicates success criteria 3. Builds commitment and engagement in learning task 4. Lesson design: input, model, check for understanding 5. Guided practice 6. Closure 7. Independent practice	4	70%
Homework	.43	Involves "tasks assigned to students by teachers that are meant to be carried out during non-school hours." Smallest effects in math. Effects greater for higher than lower ability students.	6 17	70% 76%
Computer-assisted instruction	0.37	Use of computers is more effective when there are multiple opportunities for learning and	19	76%

		when the student (not teacher) is in control of learning, when peer learning is optimized, and when feedback is optimized	23	88%
Inquiry-Based Teaching	0.31	Art of developing challenging situations-students devise and conduct experiments, analyze data, design and build models. Greater effects when teaching process rather than content. Shown to produce transferable critical thinking skills.	8 10	81% 67%
Using simulations and gaming	0.33	Typically involves use of model or game with an aim to engage students in learning. Aims to mimic real-world problems.	15 12	71% 76%

Figure 10: Influences on Student Learning & Achievement
Adapted from Hattie's Index of Teaching and Learning Strategies (Schon, 2016) & Teachers make a difference: What is the research evidence? (2003, October)

Questionnaire items 6 and 17 relate to homework. Seventy-six percent of the students felt it was important to complete homework on a daily basis, and 70% percent felt it was important to check homework in class with the teacher. The same support was shown for questionnaire item 4, which addresses direct instruction, specifically taking notes and completing practice problems in class with the teacher. The students showed strong favor for these approaches to learning mathematics and the effect sizes for both homework and direct instruction suggest they have a powerful effect on achievement.

The traditional teaching paradigm delivery of content takes place within the walls of the classroom and has students completing practice problems out of a textbook at home when a subject area expert is not present to answer questions, provide clarity, or guide students in their work (Tucker, 2012). In addition, many teachers under this model are limited in their class time to go over homework, provide the necessary new content-specific information, and guide students in practice problems. The traditional model forces all students to be on the same page at the same time, and learn at the same pace. Compare this to a blended model where direct instruction and homework are still present, but the students have a voice and choice in how they access the information, as well as the pace at which they move through the content. In order to maximize the face-to-face time with the teacher of record in the blended group, many traditional practices like taking notes and completing practice problems took place outside of teacher-time and occurred during independent-time. The teacher of record created videos and found other videos online that front-loaded the information for the following day. Students watched these videos and completed practice problems in the video during their independent-time. This practice allowed students extra time in class to work with the teacher individually and work at their own pace. One student in the blended group stated, "I love the pace and I like the fact that I get down time to work on math homework back at my school."

Questionnaire items 19 and 23 relate to students' preferences when it comes to working independently and taking ownership of their learning. Ninety-two percent of the traditional group and 86% of the blended group agreed that they wanted to take ownership of their learning. Various technology tools and resources allow for this to happen and provide students with the opportunity to play an active role in the learning process (Vygotsky, 1978). In a traditional model, the teacher has fundamental responsibility for student learning. In order for the transfer of ownership to take place, students must be given voice and choice. In a blended model, the teacher is not the only one responsible for student learning. Students are taught how to use various resources (textbook, video tutors, online simulations and websites) to access information. When students take on this ownership, the teacher is free to meet individually with students and provide feedback. According to the Blended Learning Research Clearinghouse 1.0 (2015), individualized instruction is difficult to implement, scale, or sustain in traditional classrooms, but can be facilitated by blended learning. Reducing the group size and providing instruction that is direct, explicit, and closely aligned with students' needs and prior knowledge has been shown to have effect sizes ranging from 0.65 (Hattie, 2003) to as high as 2.0 (Bloom, 1984).

Varying the context of learning and using multiple representations of a problem and solutions has been shown to have an effect size up to 0.75 (Marzano, Pickering, & Pollock, 2001). Eighty-one percent of the students felt it was important to understand multiple methods for solving the same type of problem and 76% supported tools and programs (i.e. iPads, computers, spreadsheets, apps, graphing calculators, etc.) to explore math concepts. Understanding multiple methods for solving problems while also trying to incorporate technology into lessons can be a daunting task for a classroom teacher, especially at the elementary level where one teacher is responsible for teaching multiple content areas. A blended model would allow students to access multiple resources, which in turn would allow this type of learning to take place. The teacher of record for the blended course often presented one way of solving a problem in class, but assigned students to watch videos for homework that explained alternate strategies.

The overall implications for practice require the understanding of personalization and the impact it has on students' achievement and engagement. It starts with a level of commitment from an entire system of stakeholders including community members and business partners, parents, school leadership, teachers, and students. This level of work requires as redefinition of schooling. A commitment to personalization requires ongoing support from district administration in the form of professional leaning that focuses on research based instructional best practices. It requires encouragement and support of ideas that teachers want to try in their classrooms, even if it fails. Personalization means teachers are trying new approaches to teaching and students are experiences new approaches to learning. It may be messy at times. As Hess & Meeks (2010) noted, the scope and sequence of what students have been traditionally expected to learn must be revisited while exploring a variety of delivery approaches that require student involvement.

Implications for instructional change. The results from this study guided district administrators in changing the way pre-algebra is being delivered for the 2016-17 school year. Twenty, sixth graders from eight different schools qualified to take pre-algebra based on the same district criteria. Instead of having parents drop students off at the middle school and then returning to their home school via district transportation, all students are remaining at their home school following a rotation model of blended learning. Horn & Staker (2012) define the rotation model as one where students rotate on a fixed schedule or at the teacher's discretion between learning modalities, at least one of which is online learning (p. 8). During their 90-minute math block each day, students follow a daily routine (Appendix F). Students are given a chapter outline (Appendix G) along with guided notes for each chapter. There are 3-4 teacher interactions that take place on a weekly basis with each student. The pre-algebra teacher is on a rotation schedule and sees each student (or group of students), once a week for 60 minutes. In addition, the gifted coordinator at each elementary school checks in with the students 2 times a week to check notebooks, reteach, or work one-on-one. The time with the pre-algebra teacher is spent engaging in problem solving activities, digging deeper into the content, and providing extensions based on individual student needs. When asked what they enjoy most about the format of the blended course, students reported liking the organization and being able to work at their own pace. One student said, “It is very flexible and I can follow my own schedule.” Another student said, “It allows some space.” Some of the instructional elements currently present in the blended pre-algebra course are listed in the table below. According to the Blended Learning Research Clearinghouse 1.0 (2015), these effective instructional elements are difficult to implement, scale, or sustain in traditional classrooms, but can be facilitated by blended learning (2015).

Individualized Instruction	**Commonly Studied As…**	**Example Effect Size(s)**
Individualized Instruction	Reducing group size (to 1:1 if possible); providing instruction that is direct, explicit, and closely aligned with students' needs and prior knowledge; individualized remediation and feedback	2.0 0.82 0.65
Active Learning	Facilitating self-regulated and intrinsically-motivated learning in which students have some control over and responsibility for setting and committing to relevant learning goals, pathways and pace; and are engaged in their learning	0.61
Expectations	Setting high expectations and challenging goals for learning	0.52

Figure 11: Effective Instructional Elements
Adapted from
http://learningaccelerator.org/media/12132951/BL%20Research%20Clearinghouse%201.0-050715%20(1).pdf

Creating readiness for change is a critical component of both initiating and scaling up the use of evidence-based practices and other innovations in education (Bray & McClaskey, 2015, p. 206). Although research supports the strategies and approaches being used to deliver math instruction for the 2016-17 school year, the level of support and engagement varies from parents to classroom teachers to students. For this reason, suggestions for improving the study and implications for further research are outlined below.

Recommendations for Improving Study

The following recommendations are offered as possible ways to improve this study:

1. While the same textbook was used with both groups and the classroom teachers from each group met occasionally throughout the year for planning, each teacher had the freedom to change the schedule and add in supplemental resources and projects throughout the year. One way to improve this study would be to provide a more structured list of requirements, projects, and supplemental materials across both groups. A monthly or bi-monthly dedicated planning time should be used to ensure consistency in content delivery across the groups.
2. The traditional group was guaranteed 90 minutes of math each day, however the time for the blended group varied based on the students' home school schedule. The 90-minute math block differs for each elementary school and some students from the blended group returned to their home school while math was in progress leaving 50-60 minutes of independent time. Other

students had their math block in the afternoon and had a full 90 minutes of independent time. Another way to improve this study would be to clearly identify how much time is allotted for teacher time and independent time during the math block in both groups.

3. The traditional and blended group students answered the questionnaire based on their own experience, and did not know anything different from the way they were being taught pre-algebra. In order to provide additional data for the methods and strategies being used in both models, this study could have provided the blended group with a traditional format for some units while the traditional group experienced components of the blended format. Having students participate in each model might give the researcher a clearer understanding of students' preferences.
4. Altering the model for how a course is delivered in sixth grade has implications for middle school and high school. The researcher is not suggesting all math courses move to a blended format, however, incorporating components of a blended course after sixth grade could offer some consistency and familiarity for students. Appendix C is an example of how a chapter could be organized, moving towards a blended format allowing for student choice and voice.

Recommendations for Future Studies

There is not a large research base on blended learning, especially at the elementary level. According to the Blended Learning Research Clearinghouse 1.0:

To date, most studies of effectiveness (defined in this resource as "improvements in

> intended outcomes when implemented in real life settings under ideal or routine conditions") associated with blended learning have focused on online learning as a unique learning environment, often in fully online or "virtual learning" settings, and/or with older adolescent or adult learners in higher education or industry settings. Because of this, there is no clear research evidence to date in public K-12 settings of the effectiveness of blended learning as an instructional model that integrates digital and face-to-face instruction in order to personalize learning and enable competency-based progression (2015).

The results of this study contributed to the research base on blended learning at the elementary level, however many more areas can be investigated. The following recommendations are suggested for future studies:

1. Implementing a blended learning model is not a summer project or something to jump into without proper preparation. The Blended Learning Implementation Guide further states that if the shift to blended learning feels like "just another district initiative," it is doomed to failure (Bailey, Ellis, Schneider, & Vander Ark, 2013). Districts, grade levels, and content area teams wishing to implement a blended learning model must start by defining academic goals and building support and capacity among all stakeholders. There should be proper professional learning before and during implementation with the flexibility to make adjustments throughout the process.
2. The participants in this study were sixth graders taking pre-algebra which is a two year accelerated track from their grade-level peers. Students qualify to take pre-algebra based on district criteria that have been in place for twenty years, however

there are always students right on the border who do not qualify. By offering pre-algebra as a blended course, additional students could be allowed to self-enroll in the course to see if it is the right fit. Future research could study the performance of those students who qualified using district criteria and those students who self-enrolled in the course. The interests and needs of students change over time so it is also recommended that future research include more longitudinal data of these students in an accelerated track.

3. There is not a one-size-fits-all blended learning model that works for a particular grade level or content area. In fact, Horn & Staker (2012) note that many school operators have implemented more than one blended leaning model for their students. Given the small population in one subject area at one grade level in this study, recommendations for further studies include finding the right model of blended learning and the right balance of face-to-face time with online learning time. Other variables to consider include age, gender and socio-economic status of the students. Studying these additional variables could help determine if blended learning yields greater success among different populations.

Summary

The purpose of this research was to analyze the performance of sixth grade pre-algebra students in two different teaching environments: traditional and blended. The results of this study provided information to one district and how they deliver math instruction, but also laid the groundwork for further study and implementation. Blended learning is still relatively new and little research exists on its effectiveness, especially at the elementary level. Added to the lack of research, districts are continually faced with the need to reduce budget costs while still providing a quality education to students. Fitzpatrick, Sanders, & Worthen (2010) urge schools to conduct evaluations on existing programs to make judgments about continuation, expansion, or to improve the quality of the program delivery. This change is imperative if we are to adequately prepare students for the demands of 21st century jobs.

This study used three assessments and a student questionnaire to investigate the benefits of using a blended learning model in the mathematics classroom. The analysis of the data indicated no significant difference in procedural knowledge between the two groups. The data also showed that students desire to take ownership of their learning and have preferences when it comes to teaching strategies and approaches to learning math. These preferences can be met by incorporating strategies and methods from a blended learning model. While the evidence from this study was not conclusive, it provided baseline data for implementing a blended learning model at the elementary level. The data warrants further research to examine performance at different grade levels and in different content areas.

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Appendix A

Student Math Questionnaire

Please rate the importance of each criterion for your pre-algebra experience.

	1 - Not at all Important	2	3	4	5 - Extremely Important
Taking a pre-test before each chapter to see what I already know about the topic					
Providing situations where the math topic/concept is used outside of math class					
Covering one topic/lesson in the textbook each day					
Taking notes and completing practice problems in class with the teacher					
Taking notes and completing practice problems from a video					
Checking homework in class with the teacher					
Checking homework online with the opportunity to ask the teacher questions on problems missed					
Providing multiple methods for solving the same type of problem					
Attending class 5 days a week for a set amount of time with a teacher present at all times					
Assigning projects that allow me to demonstrate my knowledge of math concepts in alternative ways (as opposed to a paper/pencil test)					
Allowing me to work at their own pace (i.e. completing multiple					

lessons in one day, taking the test when I'm ready as opposed to when the rest of the class is ready, etc.).					
Using tools and programs (i.e. iPads, computers, spreadsheets, apps, graphing calculators, etc.) to explore math concepts					
Having the ability to work with the teacher one-on-one or in a small group					
Assessing learning with quizzes and tests					
Working with a partner or a small group on problem solving activities					
Being able to communicate using mathematical vocabulary					
Completing homework on a daily basis					
Following the sequence of topics from a textbook					
Learning to work independently and take ownership of learning					

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
I need to attend math class 5 times a week for a set amount of time each day in order to be successful					
I need daily homework in math					
I want to take ownership of my learning					
I am appropriately challenged in pre-algebra					
During pre-algebra this year, I have grown in my mathematical ability					

and confidence					
I should be taught math the same way my parents were taught math					
The teacher should be the one solely responsible for teaching the math content					

How much nightly homework do you should have in pre-algebra?
0-20 minutes
21-40 minutes
41-60 minutes
Other:

Which criteria are most important for you in pre-algebra? Pick 3.

- Homework
- Opportunity to work at own pace
- Tests and Quizzes
- Additional Online Resources (videos, quizzes, wiki, etc.)
- Projects (Explain Everything, Indirect Measurement Project, etc.
- Time to work individually with the teacher
- Opportunity to make test corrections
- Opportunities for problem solving (problem solving packet, logic puzzle packet, math analogies packet, Zacarro math packet, etc.)
- Taking notes
- Other:

Appendix B

Chapter 6 Feedback

Please provide feedback from your experience during Chapter 6. For each of the statements below, tell me to what extent you agree or disagree.

	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
I feel like I successfully managed my time during Chapter 6					
I felt I had the necessary resources to succeed in Chapter 6					
I liked having choices during Chapter 6 (pace, which resources to access, etc.)					
The projects (Shopping Spree & Explain Everything) helped me see how the content in Chapter 6 is applied in real-life					
I would like to do another chapter in pre-algebra the same way we did Chapter 6 (choice & pace)					
The videos Mrs. Spady created that went over homework problems were useful					
The online video tutors provided sufficient information for each section in Chapter 6					
I participated in a small group learning session with Mrs. Spady during Chapter 6 (mini lesson with whiteboards up front)					
I could have done Chapter 6 at my home building without coming to Pre-Algebra every morning					

I had to take ownership of my learning during Chapter 6					

Advantages of Chapter 6: Please be specific about the advantages of Chapter 6. Include what you liked and why.
Your answer

Disadvantages of Chapter 6: Please be specific about the disadvantages of Chapter 6. Include what you did not like and why.
Your answer

Personalized Learning allows students to have voice and choice in their learning. What are your thoughts about having personalized learning in Pre-Algebra? Please be specific.
Your answer

Blended Learning takes a traditional classroom environment that meets face-to-face on a consistent basis and replaces part of it with online learning. What advantages and disadvantages do you see to having a blended learning environment in Pre-Algebra?
Your answer

Please provide any other feedback.
Your answer

Appendix C

Chapter 6 Syllabus: Blended Group

Chapter 6 consists of 9 sections. Unlike last chapter where we followed a pretty set schedule each day, during this chapter you will be allowed to make more choices in how you learn the content. There are several resources available for each section in the book. The chart below outlines what's available for each section. You may also find additional resources on your own. Put a check mark next to the items as you complete them.

I will share a Google Form with you where you will record your daily progress during Chapter 6. You will need to fill this out each day. At the end of the chapter, you will receive points for your daily entries.

Similar to chapter 5, you will have 4 additional items to work on throughout this chapter that will be due at the end of the chapter:

- Khan Academy Algebra Basics: $\geq$ 15 minutes/day (approximately 240 minutes or 440 total)
- Explain Everything (Section 6-7) Pick one problem from p. 339, 1-15 to explain. You may work with a partner.
- 4 Perplexors
- Shopping Spree Project (I will introduce this to the whole class on February 8)

You will be allowed to make several choices during this chapter including the amount of work you complete for each section, the pace at which you work, what you work on during class, and when you are ready to take the chapter test. Please remember your <u>Learning Agreements</u> on being a <u>Responsible and Respectful Learner</u>. If it is determined by me or your classroom teacher that you are not making appropriate choices, you may be assigned daily tasks to complete.

Section	Objectives and Vocabulary	Resources Available
6-1	I can write fractions and decimals as percents. I can write percents as fractions and decimals *Vocabulary:* percent	Online Quiz: aca-0601 4 Online Videos at PHSchool.com Suggested Book Problems: p. 306, 2-28 evens; 40-43 (video of solutions on the Pre-Al Wiki)
6-2	I can estimate percents using decimals. I can estimate percents using fractions.	Online Quiz: aca-0602 1 Online Video at PHSchool.com Suggested Book Problems: p. 311, 2-26 evens (video of solutions on the Pre-Al Wiki)
6-3	I can use proportions to find part of a whole. I can use proportions to find a whole amount or a percent.	Online Quiz: aca-0603 4 Online Videos at PHSchool.com BrainPop video on Percents Suggested Book Problems: p. 317, 2-26 evens (video of solutions on the Pre-Al Wiki)
6-4	I can use equations to find part of a whole. I can use equations to find a whole amount or a percent.	Online Quiz: aca-0604 3 Online Videos at PHSchool.com Suggested Book Problems: p. 323, 1-22 (video of solutions on the Pre-Al Wiki)
6-5	I can find percent of increase. I can find percent of decrease. *Vocabulary:* percent of change	Online Quiz: aca-0605 2 Online Videos at PHSchool.com Suggested Book Problems: p. 328, 1-18 (video of solutions on the Pre-Al Wiki)

6-6	I can solve problems involving markup. I can solve problems involving discount. *Vocabulary:* markup, selling price, discount, sale price	Online Quiz: aca-0606 2 Online Videos at PHSchool.com Suggested Book Problems: p. 334, 1-22 (video of solutions on the Pre-Al Wiki)
6-7	I can solve problems by writing equations.	Online Quiz: aca-0607 Suggested Book Problems: p. 339, 1-15 (video of solutions on the Pre-Al Wiki)
6-8	I can find simple interest. I can find compound interest. *Vocabulary:* interest, interest rate, principal, simple interest, balance, compound interest	Online Quiz: aca-0608 1 Online Video at PHSchool.com Brainpop Video on Interest Suggested Book Problems: p. 344, 1-16 (video of solutions on the Pre-Al Wiki)
6-9	I can find the probability that an event will occur. I can find a sample space. *Vocabulary:* outcome, event, probability of an event, sample space	Online Quiz: aca-0609 2 Online Videos at PHSchool.com Suggested Book Problems: p. 352, 1-16 (video of solutions on the Pre-Al Wiki)
Algebra Book	There are a couple sections in the Algebra book that cover the exact same topics we're studying this chapter.	Online Quizzes: aea-0403, aea-0404, aea-0405 Practice Worksheets on the Wiki
Chapter 6 Review	There are a couple different resources for you to review for the Chapter 6 Test. The review will be posted on the wiki along with a video going over the answers.	Online Test: aca-0652 Chapter Review from Book (on wiki) Practice Test (on wiki)

Appendix D

Chapter 6 Syllabus: Traditional Group

Ch. 6 Applications of Percents

Date	Section Topic	Homework
1/28	6.1 Percents, Decimals, and Fractions-Math Munchies Activity	p. 306 #2-28, evens; 40-43
1/29	6.1 Formative Quiz Introduce Anchor Activity	Work on Anchor Activity -DUE: 2/24Watch HW Video 6.3 -takes notes
2/1	6.3 Proportions and Percents	p. 317 #2-26 evens Watch HW Video 6.4 -take notes
2/4	6.3 Formative Quiz6.4 Percents and Equations	p. 323 #1-22Watch HW Video 6.5
2/5	6.4 Formative Quiz 6.5 Percent of Change	pp. 328-329 #1-18 6.5 Extra Practice
2/8	6.1-6.5 Summative Quiz Review	Crash Dummy & Expressions Worksheet
2/9	6.1-6.5 Summative Quiz6.6 Markup and Discount-Day 1	pp. 334-335#1-9, 26-31 with calculator
2/10	6.6 Markup and Discount-Day 1	Practice 6.6 with calculator
2/16	6.7 Write an Equation *Explain Everything Problem Solving Assignment*	Script for Problem Solving Assignment Due Wed 2/10
2/17	6.7 Problem Solving-	Watch HW Video 6.8 & Notes

	Write an Equation*Explain Everything Problem Solving Assignment* ***DUE: End of class 2/18***	Anchor Activity-Algebra & Percents Khan Coursework
2/18	6.8 Simple Interest	pp. 344-345 #1-16
2/19	6.8 Compound Interest	Practice 6.8 Compound Interest problems only
2/22	6.6 & 6.8 Formative Quiz Formulas to know – *Explain Everything Formulas Project* ***DUE: End of class 2/24***	Anchor Activity-Algebra & Percents Khan Coursework
2/23	Seminar/Explain Everything Work Day	Ch. 6 Review NO Calculator
2/24	Ch. 6 Review Calculator	Ch. 6 Extra Practice OR Online Ch. 6 Test
2/25	Ch. 6 Summative Test	Anchor Activity-Algebra & Percents Khan Coursework
2/26	Anchor Activity **AND**Explain Everything Formulas Project**DUE: End of Class**	6.9 HW Video Tutor & Notes *Finding the probability of a single event* *Using a list and sample space to find probability*

Appendix E

Learning Agreements

My success in Pre-Algebra this year will be a result of my ***active participation***. I am responsible for ***my learning,*** which means I need to keep an ***open mind***, practice ***active listening***, and use ***my resources***.

<u>Learning Agreements</u>

Be Respectful:

- I will utilize math time at my elementary school effectively and not interfere with others' learning time.
- I will work with my learning partners, provide encouraging support, and help as needed.

Be Responsible:

- I will bring my materials to class each day.
- My Pre-Algebra grade is my responsibility and I will communicate with Mrs. Spady, my classroom teacher, and my parents about my grades.
- I will be an active member in my learning community.

Be Safe:

- I will exercise appropriate bus behavior when traveling back to my elementary school.

Appendix F

Daily Routine

1. Check the wiki, Google Classroom, and your email. (http://tinyurl.com/wcspreal1617)

2. Tape/glue the note sheet into your math notebook.

3. Review the Essential Question for the Chapter

4. Fill in the blanks for "What You'll Learn" in the Lesson

5. Fill in the blanks for the vocabulary word(s)

6. Watch the Video Tutor(s) and any additional videos from Mrs. Spady. Be sure to take notes on your note sheet.

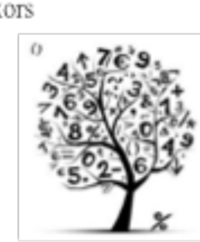
7. Work on homework and correct it using the answer key on the wiki. Record your score as a fraction at the top of the page.

8. Take the self-check quiz. Record your score on your note sheet and email Mrs. Spady your score.

9. Work on pages from the Interactive Study Guide

Other items to work on include:

- Standardized Test Review (end of chapter)
- Chapter Review (end of chapter)
- Explain Everything
- iXL Assignments
- Khan Academy (6th grade or Pre-Algebra)
- Perplexors



Appendix G

Chapter 4 Dates: Finish all work by October 28

Essential Question

Chapter 4 Outline

Why is it useful to write numbers in different ways?

Label the top of your page in your notebook with this information.

GLENCOE MATH ACCELERATED

Watch the Chapter 4 Preview Video Before Starting on the Chapter.
Wiki Link: http://tinyurl.com/wcspreal1617

Lesson	What You'll Learn	Vocab	Videos/ Tutor	Homework & Homework Score		Other Assignments iXL & Interactive Study Guide Pages
4-1	• I can write expressions using exponents • I can evaluate expressions containing exponents	• exponent • power • base	Check the wiki!	**p. 138-140** 13-57 every other odd	12	**iXL: Level J** • F.1 Understanding exponents
4-2	• I can write expressions using negative exponents • I can evaluate numerical expressions containing negative exponents	• negative exponent	Check the wiki!	**p. 143-144** 14-40 evens **p. 146** 58-72 evens	22	**iXL: Level K** • V.3 Negative exponents **p. 76 Notes** in Interactive Study Guide
4-3	• I can multiply monomials • I can divide monomials	• monomial	EDPuzzle on Google Classroom BrainPop Video on Wiki	**p. 150-151** 19-41 odds 55-60 all	17	
4-4	• I can express numbers in standard form and in scientific notation • I can compare and order numbers written in scientific notation	• scientific form • scientific notation	EDPuzzle on Google Classroom BrainPop Video on Wiki	**p. 156-158** 1-25 odd 49, 53-56	18	**iXL: Level H** • E.1 Convert between standard and scientific notation **p. 81 & 82** in Interactive Study Guide
4-5	• I can multiply and divide numbers in scientific notation • I can add and subtract numbers in scientific notation		Check the wiki!	**p. 163** 11-25 odd **p. 165** 63-68	14	
4-6	• I can find square roots • I can find cube roots	• square root • perfect square • radical sign • cube root • perfect cube	EDPuzzle on Google Classroom Brain Pop Video on Wiki	**p. 172-174** 17-35 odd 44-62 evens	20	**iXL: Level K** • A.6 Square Roots
4-7	• I can identify and compare numbers in the real number system • I can solve equations by finding square roots or cube roots	• irrational number • real numbers	Check the wiki!	**p. 178-179** 44-88 evens	23	**iXL: Level J** • A.8 Classify numbers **p. 87 & 88** in Interactive Study Guide