THE INFLUENCE OF BLENDED LEARNING ON POST-SECONDARY READINESS AND ACADEMIC ACHIEVEMENT IN MATHEMATICS: A PERSONALIZED APPROACH TO LEARNING

by

Sondra Esther Cano, M.Ed

DISSERTATION

Presented to the Faculty of

The University of Houston-Clear Lake

In Partial Fulfillment

Of the Requirements

For the Degree

DOCTOR OF EDUCATION

in Curriculum and Instruction

THE UNIVERSITY OF HOUSTON-CLEAR LAKE

MAY, 2019

THE INFLUENCE OF BLENDED LEARNING ON POST-SECONDARY READINESS AND ACADEMIC ACHIEVEMENT IN MATHEMATICS: A PERSONALIZED APPROACH TO LEARNING

by

Sondra Esther Cano

APPROVED BY

____
Sue Brown, PhD, Chair

____
Michelle Peters, EdD, Committee Member

____
Amy Orange, PhD, Committee Member

____
Jana Willis, PhD, Committee Member

RECEIVED BY THE SCHOOL OF EDUCATION:

____
Lillian McEnery, EdD, Interim Associate Dean

____
Joan Pedro, PhD, Interim Dean

Dedication

I dedicate this dissertation to my family who have provided me with unconditional love and support throughout my life. Despite the choices I made to delay my education, I received constant encouragement from my parents, David and Hester Shick, and from my husband, Eddie Cano. Any contributions I make to the development of a quality high school mathematics program in the district where I serve can be attributed to the support of my loving family.

Dad and Mom, I will forever remember the day you came to church with me in Texas and listened to me retell the story of how Tina and I portrayed the lesson of Zacchaeus and as I spoke you looked at each other and said, “She was born to be a teacher.” Those words became a beacon for me that has guided my path as a professional educator. Here I am, many years later, and now completing my third degree!

Eddie, you have been the love of my life and my rock for over thirty years! When I walked away from my bachelor’s degree, you encouraged me to finish. When I finally went back, you provided the opportunity and supported me 100%, as I finished that first degree. You have encouraged me to seek opportunities for growth allowing me to pursue my desires to continue to learn. You filled the gap at home when I needed to study – taking care of our three boys. Because of you, I have reached an educational milestone that I never thought possible.

Nick, Nate, and Noah – dream BIG! You can accomplish anything that you put your mind to.

Acknowledgements

My educational journey has been marked by milestones left by individuals placed in my path from high school through my doctoral experience. As a high school student, I never envisioned myself falling in love with learning to the point that I would pursue my education culminating in a doctoral degree in education. Somehow, God placed the right people in my life at the right time who encouraged me to keep learning and to keep growing! I would like to take some time and acknowledge those people who influenced my educational journey.

Earning three degrees from the University of Houston-Clear Lake afforded me opportunities to form meaningful relationships with faculty who have served as mentors. Dr. Sue Brown has provided me the mathematics expertise necessary to make certain my study would be meaningful to the mathematics education community and has served as a colleague and mentor for many years. Dr. Michelle Peters and Dr. Amy Orange have provided me the necessary guidance to ensure the data I collected would be measured and analyzed so that a story was told that was worth telling. Dr. Jana Willis has provided the appropriate lens with which to study my phenomenon and to ensure that the focus of the study led to personalized learning. Dr. Laurie Weaver and Dr. Judith Márquez have provided me with leadership opportunities that expanded my horizons allowing me to advocate for English learners at the state level and by giving back through teaching at the university.

The faculty at University of Houston-Clear Lake served to mentor me throughout my post-secondary journey; but my family that laid the foundation for me to continue my education. My father gave me my passion for mathematics. He kept me grounded by helping me bring content to life in the classroom for struggling learners. My mother gave me the gift of academic tenacity as I watched her work toward her bachelor’s degree when she was in her early 70's. The year my father passed away was the year my mother earned her degree as God provided her new opportunities to live without the love of her life by her side. My husband gave me the give of support as he helped me find my sense of purpose as a public educator. He was my motivator to complete my bachelor's degree, he was my partner in decision-making to pursue my master's degree, and he was my coach convincing me to pursue my doctoral degree. Without his love and support, this journey may never have happened.

Last, but not least, I want to acknowledge Mariana Prado for walking alongside me through the qualitative data collection journey as my technical assistant. Mariana is a product of the district (in which I serve) and was the valedictorian of her class. As a student at UHCL, Mariana became interested in research and looked for an opportunity to learn and grow as a research assistant. When she partnered with me as a technical assistant, she engaged in study to learn everything she could about my research and has become an advocate for personalized learning. She commented that as a student that was always seeking to reach a higher level of learning, I know that this model of instruction would have allowed me to dig deeper by using all the resources available through inquiry and project-based learning. My hope is that she carries this experience into her own classroom one day as she works to inspire the next generation of mathematics learners.

ABSTRACT

THE INFLUENCE OF BLENDED LEARNING ON POST-SECONDARY READINESS AND ACADEMIC ACHIEVEMENT IN MATHEMATICS: A PERSONALIZED APPROACH TO LEARNING

Sondra E. Cano
University of Houston-Clear Lake, 2019

Dissertation Chair: Sue Brown, PhD

Personalized learning through blended learning is emerging as an educational practice with promising potential to close the academic achievement gap in high school mathematics and produce post-secondary ready mathematics learners. National data indicates mathematics growth has stagnated over the past several decades leaving opportunity for innovation to permeate the high school mathematics classroom to influence change. Examining the influence of blended learning on post-secondary readiness and academic achievement in a large urban school district in the southeast region of Texas indicated that blended learning instruction was meeting the promise of personalized learning for all students. The sequential mixed methods study provided observable and teacher perceived characteristics evident in the blended learning classroom while quantitative data measured the influence of blended learning on post-secondary readiness and academic achievement using an independent t-test. Blended learning was further investigated using Chi-squared test of Independence and cross tabulations to investigate the relationship between blended learning and post-secondary readiness as well as academic achievement. Paired samples t-test measured the difference in PSAT scores.

Although no statistical significance was found when measuring post-secondary readiness, pockets of promise emerged when measuring academic achievement. Mean score differences were higher for students participating in blended learning when compared with students participating in traditional learning. Trends in the blended learning classroom demonstrate evidence of self-directed learning orchestrated by the teacher acting as a facilitator. Further evidence of personalization collected during classroom observations and teacher interviews demonstrated that in the blended learning classroom the needs of every student were considered instead of holding all students' hostage to the pacing of the teacher. The promise of closing the achievement gap in mathematics has great potential as the blended learning model of instruction continues to grow in implementation in the participating district and across the United States.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I:

INTRODUCTION

In the United States (U.S.), it is common to hear expressions of disinterest in mathematics or even disdain for the subject. The study of mathematics can elicit an anxiety that results in a negative impact on mathematics achievement (Ashcraft & Moore, 2009; Passolunghi, Caviola, De Agostini, Perin, & Mammarella, 2016); yet mathematics is a necessary component of success in today's highly technical society. Minsky (2016) reported on the top 10 highest-earning college degrees with the highest salary potential, and upon inspection a common element existed: mathematics. Students learn from an early age that they are either excellent in mathematics or that they cannot perform mathematically, thus adopting a mindset in mathematics that is fixed according to performance (Dweck, 2006). Brain evidence indicates every child can excel mathematically, from elementary to high school (Boaler, 2016). This relevant finding is important for the futures of our students because now, more than ever, it is imperative to graduate students who excel mathematically to be competitive as a nation and fulfill highly technical jobs.

The evolution of society from industrialization to personalization has not permeated our school systems, where the status quo is still standardization (Kallick & Zmuda, 2017). "We are living in a post-industrial age, but our public education system still reflects the careful design of an earlier era" (Summit Learning, 2017, p. 11). With the passing of Every Student Succeeds Act (ESSA), a foundation was established to structure a school system to support the 21st century learner. In 2015, ESSA was signed into law, requiring technology integration using blended learning strategies to personalize learning and promote college and career readiness for all students (U.S. Department of Education, 2015). States' accountability for post-secondary readiness is at the forefront of expectations, holding local districts accountable for not only graduation rates and academic achievement, but post-secondary readiness.

State accountability systems mirror the expectations established in ESSA by including measures of post-secondary readiness, graduation rate, and academic achievement. In Texas, districts are rated using an A-F system in three domains: (a) student achievement, (b) school progress, and (c) closing the gaps (Texas Education Agency [TEA], 2018a). Student achievement is calculated using the following breakdown: (a) *State of Texas Assessment of Academic Readiness* (STAAR) performance weighted 40%, (b) *College, Career, Military Ready* (CCMR) weighted 40%, and (c) graduation rate weighted 20%. The STAAR Algebra I EOC is used to determine the mathematics performance level of high school students and is a determining measure necessary for high school graduation. In the state accountability system, STAAR performance is just as important as post-secondary readiness (defined through CCMR indicators). College, Career, Military Ready (CCMR) uses multiple sources to determine the number of students who graduate with the necessary foundation for success in college, career, certification programs, or the military. The challenge in our schools, then, is to raise the rigor and provide equitable experiences for all students increasing academic performance that in turn influences post-secondary readiness.

Research Problem

National data indicate that high school students have not made significant gains in mathematics performance over four decades (National Center for Educational Statistics [NCES], 2015b). Similarly, the Organization for Economic Co-operation and Development (OECD, 2016) measured mathematics performance among 15-year-olds and reported no significant gains or losses over time as measured by the Programme for International Student Assessment (PISA). The lack of high school mathematics progress is disconcerting and problematic for the future growth and development of our nation. Mathematics has been defined as the gatekeeper to future economic success (Wonnacott, 2011), but is also a necessary skill to be a contributing member of society. Students who do not demonstrate post-secondary readiness in mathematics begin their college careers in non-credit-bearing remedial mathematics classes. The remedial classes become the gateway to credit-bearing mathematics classes, resulting in dramatically reduced chances of students graduating from college (Young, Hodge, Edwards, & Leising, 2012). Evidence indicates there is a need to engage all students in the study of mathematics that will both improve mathematics achievement and lead to improved mathematics post-secondary readiness. Personalizing the learning path for students could bring equity to the classroom and ensure all students are given the opportunity to succeed.

Underprepared high school students for college level mathematics is a U.S. national concern (Atuahene & Russell, 2016). College board (2018) reported that 47% of test takers met the benchmarks in both evidenced-based reading and mathematics – a mere one percent gain from 2017. According to the Texas Higher Education Coordinating Board (THECB, 2016), only 30% of Texas seniors are college ready, which is symptomatic of non-engaged high school mathematics students. Zelkowski (2011) explains the difference between college readiness and college preparedness. College readiness means students are meeting college entrance exam minimums while college preparedness means meeting state graduation minimum requirements – leaving a gap between definitions where students fall victim. To reverse this trend and to increase the number of college-ready mathematics students, the need is to engage students in learning mathematics at rigorous levels while in high school (Boaler, 2016; Zelkowski, 2011).

Furthermore, the gap in achievement between student groups needs immediate attention so that all students engage in mathematics learning to reach their college and career goals. Flores (2007) examined mathematics education and defined achievement gap as an opportunity gap. An opportunity gap is further explained as the higher socio-economic status of students and schools, the higher the benefit of more and better resources (OECD, 2013). The highest performing school systems are those that allocate educational resources more equitably among advantaged and disadvantaged schools. According to National Council of Teachers of Mathematics (NCTM, 2014), “An excellent mathematics program requires that all students have access to a high-quality mathematics curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential” (p. 59). ESSA calls for the success of all students by advancing equity and ensuring that high standards be taught to prepare students to succeed in college and career (U.S. Department of Education, 2015).

Traditionally marginalized student groups continue to underperform nationally, and this makes the achievement gap an interminable problem (McKown & Weinstein, 2008; Whipps-Johnson, 2016). The close relationship between learning outcomes of students in the U.S. and socio-economic background is directly related to deficient performance in education (OECD, 2013). The need to minimize the relationship between socio-economic status and performance is imperative in meeting the demands of a technical-future that has yet to be defined. Research is abundant detailing the outcomes that are possible when systems address the obstacles impeding mathematics success from students who are traditionally marginalized in the mathematics classrooms (Boaler & Staples, 2008; Cross et al., 2012; Gutiérrez, 2000; NCTM, 2014). The hope is that integrating technology through blended learning strategies will personalize learning and reduce the gap caused by race/ethnicity or socio-economic status and produce students who are highly engaged in mathematics learning while increasing their mathematical achievement and post-secondary readiness.

One of the goals of blended learning is to personalize the learning path for every student while developing a growth mindset in mathematics that contributes to an increase in their mathematical self-efficacy. According to Boaler (2016), in order to develop a growth mindset in mathematics, students must take an active role in sense-making and in understanding the problems given. Zimmerman, Bandura, and Martinez-Pons (1992) report that self-directed learning embraces thinking skills and the self-regulation of three factors: motivation, learning environment, and self-directedness. According to Kallick and Zmuda (2017), “A student-driven model of personalized learning attends to the human architecture – to how teachers and students interact with one another” (p. 17). Chao, Chen, Star, and Dede (2016) report that the use of technology-based resources increases students’ mathematical motivation and heightens their mathematical mindset, developing greater confidence in problem solving. It is the hope of this researcher that the opportunities afforded all students through personalizing learning in a blended learning environment will result in higher mathematics achievement and reduce the level of under-prepared students exhibiting a low self-efficacy in mathematics.

Blended learning is a model that has unique characteristics and is beginning to gain traction as more research is published on the topic. Henry (2018) defined blended learning as the new normal in public and private education, with implementation influencing graduation rates. Models of blended learning span a wide variety of implementation models with various key attributes and characteristics. Marshall (2018) conducted a qualitative study to determine best practices and processes for blended learning implementation. One key element consistent across models is the use of technology. Young, Gorumek, and Hamilton (2018) conducted a meta-analysis of current research on technology integration in the mathematics classroom and found that grade level, duration, and the instructional role of technology are key components of successful implementation.

Integration of technology in the mathematics classroom supports personalization of content. Walkington, Sherman, and Howell (2014) discuss personalization in mathematics as tailoring word problems to connect with student interests, such as sports, after-school activities, part-time jobs, and digital media. Hong, Chen, Chang, and Chen (2007) studied personalization in relation to computer adaptive testing and found that a generated learning path based on difficulty level had a positive impact on student performance. Duncan (2013) described personalized learning as a tailored approach that is paced and addresses the interests of the individual student. U.S. Department of Education (2015) defines blended learning as the integration of both technology and face-to-face instruction, leveraging both elements to promote student control over time, path, and pace as needed – a clear path to personalization. As education policy changes to improve student outcomes, the implementation of policy change resides within each classroom where learning in orchestrated by the teacher. The change needed to improve student outcomes requires mathematics teachers to shift from traditional beliefs and classroom practices to promote equitable success for all students (NCTM, 2014). The challenge facing education is to organize mathematics learning by determining the appropriate blended learning model through research and evaluation that posits students at the center of the learning. Placing students at the center of learning and providing opportunities for personalized learning paths have the potential to engage students and motivate them to succeed. The result could be improved mathematics performance and post-secondary readiness where students excel in problem solving.

Significance of the Study

Personalized learning through blended learning has emerged as an educational practice with promising potential to close the academic achievement gap in mathematics and produce post-secondary ready learners. Early implementers of blended learning are showing positive progress impacting student learning (Wilka, Gutiérrez, & Price, 2017). "In multiple districts, STAAR exam results show higher academic achievement levels for students in blended learning classrooms … [with] students who 'met' grade level increasing by 36%" (Wilka et al., 2017, p. 1). According to the TEA (2013), STAAR tests have been vertically aligned to inform post-secondary readiness. Students scoring at the *met grade-level performance* are defined to be on track for post-secondary readiness. Research has yet to be published measuring the influence of blended learning on post-secondary readiness, leaving a gap in the research. It was the hope of the researcher to measure the influence of blended learning on post-secondary readiness and academic achievement to inform practice as blended learning becomes established as the norm in educational practice for high school mathematics.

Research Purpose and Questions

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning. This study addressed the following research questions:

1. Does participation in blended learning influence post-secondary readiness in mathematics?
2. Is there a relationship between blended learning participation and post-secondary readiness?
3. Is there a statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018?

4. Does participation in blended learning influence academic achievement in mathematics?
5. Is there a relationship between blended learning participation and mathematics achievement?
6. What are the observable and teacher perceived characteristics of the blended learning classroom?

Definitions of Key Terms

The following terms are defined for the purpose of the study.

Achievement gap: When one or more groups of students outperforms another group and the difference in average scores for the two groups is statistically significant (NCES, 2015b).

Blended learning: Personalized learning in which students set and track goals, learn content at their own pace, complete deeper learning through concept units, and are mentored by a classroom teacher (Summit Learning, 2017).

Conceptual knowledge: The connection of mathematics concepts, operations, and relations (NCTM, 2014).

Mathematics achievement: A measure of academic performance as indicated on *State of Texas Assessments of Academic Readiness* (STAAR). Students who "meet grade level" performance are likely to be successful in the next mathematics course and are on track to be post-secondary ready (TEA, 2017).

Post-secondary readiness: Preparing students for the transition from high school to multiple pathways after graduation, or more specifically to being ready for college (WestEd, 2016).

Procedural knowledge: Flexibility to carry out mathematical methods developed and extended from conceptual understanding (NCTM, 2014).

Self-directed learning: The student's ability to apply learning strategies, monitor performance, and evaluate academic progress (Zumbrunn, Tadlock, & Roberts, 2011).

CHAPTER II:

REVIEW OF RELATED LITERATURE

Engage in a casual conversation with adults and bring up the subject of mathematics, and a common disdain for the subject frequently emerges. Often, individuals have adopted a belief that they cannot perform mathematically and then this belief is typically held for the rest of their lives (Boaler, 2016; Dweck, 2006). The mathematics dialogue needs to change so that as a nation we can meet the demands of the workforce, which increasingly requires mathematical acumen, scientific inquiry, technological ingenuity, and engineering processes. The projected need for science, technology, engineering, and mathematics (STEM) college graduates is close to one million, which is vastly underfulfilled by the 300,000 STEM graduates currently completing a degree in one of these areas (President's Council of Advisors on Science and Technology, 2012).

A key to increasing the number of STEM-motivated students can be found inside our nation's high school mathematics classrooms. The mindset shift toward mathematics is promising when you walk into a blended learning classroom: student engagement is high, differentiation is the normal, and students are directing their own learning while the teacher facilitates learning. This approach to classroom instruction is redefining the teacher role as learning is personalized for the individual student – in stark contrast to batch learning found in the traditional classroom model.The review of literature encompasses topics relevant to building a case for reaching all learners in high school mathematics through personalization in a blended learning model of instruction. Engaged mathematics students can bolster the numbers of students graduating college and career ready and potential to fulfill the necessary number of STEM-motivated students. This chapter will present a thorough review of the current literature addressing mathematics post-secondary readiness, mathematics achievement gap, and blended learning as well as presenting a theoretical framework.

Mathematics Post-Secondary Readiness

College Readiness and Mathematics

Houser and An (2015) examined how student demographics and California High School Exit Exam (CAHSEE) predict college readiness in mathematics. The researchers believed that the findings of this study would identify successful mathematical practices and result in an increase in college-ready minority students. Serving as the population for the study was a magnet high school in southern California with a total population of 1,700 students and a demographic profile of 46% African American, 52% Hispanic, and 2% Asian or other. The data collected consisted of participant demographics and participant scores in the California Standards Test (CST) in mathematics, ELA, and science; CAHSEE in mathematics and ELA; and Early Assessment Program (EAP) in mathematics. In California, EAP is used to measure a student's mathematics skills to determine whether the student is on track for college readiness. The test is administered during the spring semester of the secondary junior year. The design of the study was to use regression to predict college readiness in mathematics based on EAP scores used as the dependent variable.

The meaningful results of the study confirmed that students who are most likely to be college ready in mathematics develop conceptual understanding in mathematics as evidenced by the correlation between CST science and CST mathematics as the best predictors of college readiness. Overall, the combination model including academics and demographics did not prove to predict college readiness; however, evidence did indicate that CST science and CST mathematics serve as strong indicators.

Atuahene and Russell (2016) used multiple linear regression, Cochran Mantel Haenszel (CMH), Chi-square test, and independent t-test to examine student readiness for entry level college courses in a U.S. four-year public university. The study was conducted utilizing freshman data obtained from the Office of Institutional Research for Fall 2009 and Fall 2010. The sample was comprised of 1,315 participants who enrolled in at least one of the following mathematics courses: (a) developmental mathematics, (b) introduction to mathematics, (c) calculus-based mathematics, (d) algebra and trigonometry, (e) college algebra, or (f) introduction to statistics. Of the participants, 726 (55%) were female and 589 (45%) were male with 1,043 (80%) White/Caucasian and 264 (20%) underrepresented minorities [URM] (including Asian, Black, Hispanic, multi-racial, and other ethnic minorities). Of the participants, 224 (17.03%) were enrolled in calculus-based mathematics, 225 (17.11%) were enrolled in development mathematics, 382 (29.05%) were enrolled in introduction to statistics, and 484 (36.81%) in algebra, trigonometry and college algebra.

SAT-Math scores were used to determine students' college readiness for selected mathematics courses and final grades were used to indicate students' mathematics performance. Students were placed into their freshman mathematics course based on their SAT or ACT mathematics score. If a student wished to enroll in a higher level mathematics course, then an additional placement test was administered at the university level to determine ability level. Students who did not meet the university criteria for admission, but demonstrated potential, could be admitted as a special admit and placed in developmental English and mathematics courses (as needed). For the purpose of this study, admission groups were divided into two categories: (a) regular students who met admission requirements, and (b) transition students who were special admits.

Descriptive statistics indicated approximately 76% of the sample were academically ready for mathematics courses based on their SAT scores and placement levels with approximately 23% academically prepared for calculus-based coursework. Demographically, 67% of White students were academically prepared for college-level mathematics with only approximately 9% of underrepresented minorities ready for college-level mathematics. Of the students admitted into the university, approximately 60% of African Americans and 42% of Hispanics as compared to 9% of White students were placed in the non-credit bearing remedial courses. Of the students admitted into the university, approximately 40% of African Americans and 58% of Hispanics as compared to 92% of White students who were placed in credit-bearing mathematic courses.

Multiple linear regression analysis was conducted to determine if SAT-Math socre was a valid predictor of students' success in college level mathematics. Cochran Mantel Haenszel (CMH) chi-squared test was conducted to determine if there is any difference in performance of selected college mathematics courses between gender and between the two admissions groups. Statistical significance was found between male and female performance in some courses, e.g. algebra and trigonometry; but not statistically significant for calculus. For developmental mathematics and statistics courses, gender was found to be statistically significant. Females were found to perform better than males in algebra and trigonometry, developmental courses and in statistics. Statistically significant differences were found between admission groups for algebra and trigonometry, developmental mathematics, and statistics with no statistical significance for calculus-based courses.

Independent t-test was performed to examine the differences between student performance and ethnicity. Statistical significance was indicated between majority and URM students in algebra and trigonometry with the majority outperforming the URM.

No statistical significant difference between majority and URM students in developmental mathematics courses was found.

Off Track to College Readiness

Royster, Gross, and Hochbein (2015) used event historical analysis (EHA) to explore when the indicators of college readiness in English and mathematics appear in student performance. Variables included in the study consisted of gender, first-generation college status, college aspiration, college preparatory course enrollment, and participation in organized, extracurricular activities. EHA is a non-traditional approach to regression used in other fields, such as demography and biology, to conduct longitudinal analyses. The sample describing readiness in mathematics was composed of 4,415 grade 8 students from Jefferson County Public Schools (JCPS) in Louisville, KY, who were enrolled in September 2007 and had an EXPLORE (*American College Testing* [ACT]'s 8th-grade college readiness assessment) score. Students were then tracked through the administration of the ACT in 2011.

The college aspiration variable was measured using student self-reported information denoting educational plans beyond high school. Student transcripts were analyzed to measure college preparatory course enrollment, while first-generation status was determined if either parent held a bachelor's degree. The Kaplan-Meier estimate indicated that not all students met college readiness benchmarks by grade 11 ACT administration. The results also indicated that gains were demonstrated by students in the cohort throughout high school, with gains in mathematics appearing in grade 11 for students who demonstrated college readiness early. Students who did not demonstrate college readiness early were less likely to become college ready as they progressed through their high school career, meaning students had a higher chance of being college ready in grade 8 than in grade 11.

Students who had at least one parent who had graduated from college had a positive relationship with measuring college readiness. Males were more likely to be college ready in mathematics and females more likely to be college ready in English. College aspirations and participation in college preparatory courses showed a strong association with college readiness, whereas participation in extracurricular activities showed a negative association. The results of this study show that to meet college readiness benchmarks after grade 8, students who have college aspirations and who participate in college preparatory coursework can increase their likelihood of being college ready.

Mathematics Achievement

Race and Mathematics Achievement

Eradicating demographic differences between students who are post-secondary ready and students who are not is a critical issue facing education. Addressing post-secondary readiness through achievement has the potential to eliminate this problem in education. Gender issues should be addressed earlier in academics, as well as race/ethnicity issues, toward promotion of equitable achievement for all. Brown-Jeffy (2009) examined the relationship between students of different ethnic backgrounds and achievement in mathematics. The researcher believed that what happens inside the classroom and inside the schools significantly affects student outcomes in mathematics. Mathematics achievement data were retrieved from the High School Effectiveness Study (HSES), developed by the Department of Education's National Educational Longitudinal Study of 1998 (NELS). The sample extracted from this large data set included 3,392 students in 177 schools who attended the same high school between the 10th and 12th grades and who attended schools in the 30 largest metropolitan areas in the United States. The item response theory (IRT) estimated number-right score (Hambleton &

Swaminathan, 1985) was used to measure gains in mathematics from 10th grade to 12th grade. Hierarchical linear modeling (HLM) was used to examine school differences in mathematics while concurrently examining racial gaps in mathematics achievement.

Results from this study indicate that socio-economic status had the highest impact on student achievement when analyzed at the student level; but at the school level, socio-economic status was not a statistically significant factor. Race, however, was a crucial factor. By the 12th-grade year, the gap in achievement by ethnicity was astounding. The mathematics achievement gap left Black students 10 points behind White students, Hispanic students 8 points behind White students, and Asian students 5 points ahead of White students. A Chi-square statistic was used to determine if mathematics achievement differed significantly between schools and the result indicated a significant difference in mathematical achievement of students across schools. The results of this study reveal that schools with large populations of Black and Hispanic students have lower mathematics achievement for all students, which is consistent with prior research that suggests quality of school environment leads to lower academic achievement. “These results seem to suggest that the kinds of schools may be less important than the percentage of students who are in the schools” (p. 402). The researcher believed that studying the placement of students in academic classes within schools could be a way to reduce the impact of the race-based achievement gap in mathematics.

Achievement Gap and Mathematics

Achievement gap is a concern at both the high school and post-secondary level. Wheeler and Bray (2017) examined the correlation between demographic variables and academic success at a two-year institution in rural Alabama. A sample of 10,003 students enrolled in Mathematics 100 during the period beginning in fall 2002 and ending summer of 2013 at a two-year institution in Alabama was used for the study. Logistic regression was conducted to determine if gender, race, or developmental status were predictors of pass/fail status in Mathematics 100. The results of the test indicated female students had higher odds of passing Mathematics 100 than males and White students had higher odds of passing than non-White students. A logistic regression was also conducted to determine whether gender, race, or developmental status were predictors of graduation. The results of the test indicated females had higher odds of graduating along with non-White students, and students placed in developmental mathematics also had higher odds of graduating. The researchers note that not all students intend to graduate from a two-year institution; but rather to transfer to a four-year institution and could play a role in the graduation results.

Demographic variables were found to impact student success in a first level college mathematics course and some factored into whether a student would graduate or not. A surprising result in graduation was that females, non-Whites, and developmental students had higher odds of graduating. Demographics are factors that affect mathematics achievement at both the secondary and post-secondary levels; but other factors exist including the classroom teacher and instructional focus.

Factors Affecting Mathematics Achievement

Instructional focus in mathematics classrooms has been the subject of mathematics wars for decades; but as written by National Council of Teachers of Mathematics (2014), building procedural fluency through conceptual development is a critical component of successful mathematics instruction. Yu and Singh (2016) studied two important teacher factors that affect student success – (a) how caring the teacher is, and (b) whether the instructional focus is on mathematics concepts or mathematics procedures. Teacher support and academic instructional focus have rarely been investigated in high school, even though they have been recognized as important in the mathematical success of students. A stratified random sampling method resulted in identifying 944 schools in stage one of a two-stage sampling design. A random sample of 25,206 grade 9 students were then identified in stage two of the design. The sample was drawn from the High School Longitudinal Study of 2009 (HSLS:09) and yielded a national representation of grade 9 students.

Descriptive statistics were used to determine a general profile of student characteristics, teacher practices, and the correlation among variables. A confirmatory factor analysis (CFA) was used to determine if the selected items had significant loadings on the latent variables. Modifications were made until the measurement model achieved an acceptable fit with the data. The fit statistics, path coefficients, and t-test statistics were examined to evaluate the model. The researchers' hypotheses on teacher practices were partially confirmed, indicating that teacher support had a significant indirect influence on student mathematics achievement through self-efficacy. Teacher support also had a positive influence on student mathematics self-efficacy and interest in mathematics. The results indicated that conceptual and procedural approaches did not significantly influence students' self-efficacy in mathematics or their interest in mathematics courses; however, the teaching approaches did significantly affect student achievement. Conceptual development in mathematics had a positive effect on mathematics achievement while procedural development in mathematics had a negative effect on that achievement. A correlation was noted between teacher classroom practices and prior student achievement and family socio-economic status. Students with higher family socio-economic status and prior mathematics achievement were more likely to have teachers who use conceptual development practices and were more likely to perceive higher levels of teacher support.

Reform Barriers and Mathematics

The literature regarding best practices in mathematics has yet to permeate the classrooms in the U.S., resulting in inequitable practices that promote the gap in mathematics achievement. Desimone, Smith, Baker, and Ueno (2005) examined how mathematics teaching in the United States is organized and how it compares with mathematics teaching in other nations. Two different types of analyses were conducted: (a) estimation of the numbers of U.S. grade 8 mathematics teachers engaged in conceptual teaching and the number engaged in procedural teaching, and (b) examination of the barriers to effective implementation of more conceptual teaching in the U.S. Mathematics education in the U.S. was then compared with other nations regarded as having high-achieving educational systems (e.g., Japan and Singapore). A detailed analysis of an in-depth teacher questionnaire, completed as part of the Trends in International Mathematics and Science Study-99 (TIMSS-99), was used to develop indicators of teaching strategies that measure conceptual and procedural instruction. The five barriers to effective conceptual instruction implementation analyzed included: (a) individual autonomy inhibits widespread change of mathematics instruction, (b) an increase in conceptual teaching strategies means a reduction in procedural fluency strategies, (c) conceptual teaching is only appropriate for high achieving students, (d) large class sizes prevent teachers from implementing conceptual teaching strategies, and (e) only teachers with a strong knowledge of mathematics teaching and learning can effectively implement conceptual teaching strategies.

The sample for the study came from the TIMSS-99 participants across 38 countries. A random sample of one grade 8 mathematics classroom from approximately 150 public and private schools in each country, providing the researchers with an operational sample of 6,171 teachers who answered all the teacher items, was included in the study. The instruments used were surveys completed by the mathematics teachers and student mathematics assessment and background questionnaire data aggregated to the teacher level. Exploratory factor analyses of the conceptual teaching items were conducted with the combined sample of 38 TIMSS countries. The mean conceptual score across all four items in the composite and the mean computation score was used to calculate a variable representing the ratio of conceptual to procedural instruction. The researchers controlled for the level and distribution of student socio-economic status and for class average achievement because of the high correlation between the variables. Teacher content knowledge was measured using two proxy measures – possession of a degree in mathematics, or a degree in mathematics education and number of years of teaching experience.

Country-level means and standard deviations for the teacher variables associated with mathematics achievement were analyzed. Within-nation coefficients of variation were calculated for the use of computational teaching strategies and conceptual teaching strategies. A two-level model was used to predict teaching strategies on the bases of class-level achievement, class size, and teacher qualifications; and then a within-country correlation was used to compare U.S., Japan, and Singapore. Teaching strategies were regressed on class average achievement and compared regression lines across the TIMSS countries. The researchers conducted their analyses using the random coefficients model allowing each of the relationships estimated in each of the six models to vary randomly across countries. Follow-up analyses of the U.S., Japan, and Singapore were conducted to examine the within-country patterns in the relationships among school, teacher, class characteristics, and teaching strategies.

The results of the study indicate that teachers in the U.S. do use procedural strategies in most lessons, but at the comparatively same rate as in the 38 TIMSS-99 countries. Teachers across countries spend less time using conceptual teaching methods than procedural teaching methods. The assumption that teachers in the U.S. vary more in their instruction than teachers from other countries was not supported by the data. The assumption that an increase in one type of instruction means a decrease in the other is also not supported by the data. The researchers found using regression lines that the relationship between conceptual teaching and class average achievement is similar across countries. When compared with Japan and Singapore, the U.S. mathematics teachers tend to use conceptual teaching less often with lower-achieving students. In the U.S., the ratio of conceptual strategies to procedural strategies use declines as class average achievement declines, while in Singapore and Japan this trade-off is less apparent in the data. The assumption that larger class sizes prevent use of conceptual teaching strategies is not supported by the data. Mathematics teachers with and without degrees in mathematics were no more or no less likely to use procedural strategies or to use conceptual teaching strategies; furthermore, no meaningful relationship was determined between teaching experience and the use of strategies in mathematics instruction.

The important finding in this research is a partial explanation of why poor students in the U.S. do worse than poor students in other countries. Teachers in the U.S. differ their instructional strategies in terms of achievement and income level; high achieving countries do not. The instructional debate in the United States regarding procedural and conceptual approaches among low achieving students can be informed by practices in other countries.

Blended Learning

Graduation Rate and Blended Learning

Before ESSA, No Child Left Behind [NCLB] (U.S. Department of Education, 2001) sought to close the achievement gap between minority students and their advantaged peers. Federal regulations stemming from NCLB resulted in a focus on graduation rates and increasing the number of students who made adequate yearly progress improving their post-secondary readiness. While ESSA continues the goal of NCLB, the new federal law requires students to be post-secondary ready and includes the use of blended learning as a strategy to achieve this goal. Henry (2018) studied the impact of blended learning on graduation rate using a paired samples t-test to measure the difference before and after implementation. “As districts seek to be more innovative and efficient, blended learning for the purposes of credit recovery is an option to help schools achieve better results” (Henry, 2018, p. 11). An intervention to improve graduation rates through credit recovery at the participating high school utilizing the one-to-one technology provided was the treatment in the study. The sample population for the study was an urban high school in northwest Indiana with a graduation rate of 39.3% in 2014 and of 38.6% in 2015. All students at the participating high school with insufficient numbers of credits in grades 10 through 12 were participants in the study. The variables considered in this study were course completion and graduation rate, dependent variables, and the blended learning program, independent variable.

The researcher used descriptive and inferential analysis to determine if there was a statistically significant difference between graduation rate and course completion before and after the blended learning implementation using a statistical significance value of $p \leq .05$. The results of the study indicated that blended learning had a significant impact on graduation rate and the number of credits completed by participating students with graduation rate increasing to 55.9%.

Personalized Learning and Blended Learning

Basham, Hall, Carter Jr., and Stahl (2016) focused a study to identify the design characteristics of personalized learning and the initial results of personalized learning environments. The sample population was an urban reform district (URD) with approximately 6,500 students in kindergarten through grade 12 from a northern central state. The state takeover URD operated 12 schools across the large, urban area and, by design, used technology, data, and human practices to support a personalized learning environment with an extended school day (7.5 hours) and extended school year (210 days). The primary focus of the study was to determine which elements of design were working within these environments compared with which elements were not working and to support the design of environments and practices that worked throughout the district.

Over 50 observations were conducted by the researchers during an 18-month window of time. The observations were conducted monthly within a two- to three-day window. The researchers were free to move about the district at will to (a) talk with staff and students and parents, (b) watch day-to-day operations, and (c) conduct observations. Researchers developed initial themes from the emergent observations and then conducted observations and interviews to support an operationalized understanding of the principles and practices. An instrument to measure Universal Design for Learning (UDL) was used to align practices to the UDL framework. The UDL is a scientifically based framework supporting the differentiated needs of all learners through multiple means of engagement, varied information representation, and mixed assessments of understanding. Schoolwide data obtained from school year 2012-2013 were used to investigate factors associated with student performance. A multi-level coding process was used to determine design principles and practices. Generalized linear mixed modeling (GLMM) was used to identify the variables that significantly contributed at least one-year growth. The models included the fixed effects of age, days from enrollment to start, gender, ethnicity, citizenship, limited English proficiency, disability, individual education plan (IEP), and their potential interactions.

The findings from the research indicate that from an observational stance, student self-regulation was omnipresent, being consistently used throughout the personalized learning environments. The overriding integration of UDL was a heavily identifiable focus within the environments. The use of various protocols and strategies to help support both teacher and student with decision-making in establishing personalized pathways was routinely evident. Unlike traditional classrooms, students assumed an active role in assuming the responsibility for their learning. Teachers assumed the role of designing and maintaining an environment that supported student self-regulation by providing tools, strategies, and scaffolds for success. Teachers discussed with the researchers the use of student data and student voices in planning pathways for student learning. Students gained understanding of information through a variety of forms, including (a) instruction from the teacher, (b) various forms of technology, (c) expert peers, (d) traditional reading material, and (e) learning coach (if needed). By mid-year, more than 25% of students across the entire district had already achieved more than one year's growth in both reading and mathematics, indicating that the other 75% of students did not obtain one year's growth in the same time frame.

Technology played a significant role in the implementation of personalized learning. A learner-management system (LMS) was used to support individualized learning pathways and gather support data. Teachers uploaded digital learning material to support student learning of specific competencies. Learners could self-identify and report comfort level with content, level of engagement, and level of effort exhausted on each learning task or competency. To build redundancy, progress trackers were also posted with each classroom to identify learner movement and growth through individual competencies. The availability and regular use of student progress data provided teachers and students with the information necessary to effectively personalize instruction for all

URD students. The researchers determined that specific design elements apparent within these settings could be replicated and researched in other settings. It is also important to note that learners both with and without disabilities can be successful in personalized learning environments.

Web-Based Tools and Blended Learning

Dabbagh and Kitsantas (2005) examined which web-based pedagogical tools (WBPT) were most effective in supporting student self-regulated learning (SRL) while completing course assignments. The sample consisted of 65 students ranging in age from 22 to 45 years, with 22 male participants and 43 female participants. The students were enrolled in three college courses that utilized a course management system (CMS) to support course events and learning tasks. Two of the three courses were selected for additional qualitative data collection because they were taught by the same instructor, which provided a comparable sample for data analyses.

Participants completed a questionnaire gathering personal data, such as major area of study, gender, and age. The Motivated Strategies for Learning Questionnaire (Pintrinch, Smith, Garcia, & McKeachie, 1993) was used to determine if participants differed in their self-regulation across the three courses. A web-supported self-regulation questionnaire (WSSRQ) was administered to students enrolled in the three courses to determine whether the four categories of WBPT supported or promoted the six processes of SRL. The four categories of WBPT are as follows: (a) content creation and delivery tools, (b) collaborative and communication tools, (c) administrative tools, and (d) assessment tools. The six processes of SRL were these: (a) goal setting, (b) use of task strategies, (c) self-monitoring, (d) self-evaluating, (e) time planning and management, and (f) help-seeking. Students were asked to rate each of the SRL processes on a scale of one to five in terms of the degree to which each of the WBPT supported the SRL process.

Student perceptions of the usefulness of WBPT in supporting completion of course assignments questionnaire (SPU-WBPT) to elicit student responses to the usefulness of WBPT and the SRL process that these WBPT evoked while completing these course assignments.

Two trained graduate students independently coded student responses to questions and were asked to examine whether students' text responses to the questions contained evidence of SRL processes. The graduate students provided a count frequency for each of the SRL processes detected and the CMS features reported as useful for each assignment. Additional content analysis was performed by the researchers to triangulate the findings and resolve discrepancies between the two graduate students' coding.

A one-way analysis of variance (ANOVA) was performed using the MSLQ data to determine any initial differences in students' self-regulation among the three courses. The result yielded no significant difference, showing all students exhibited the same level of SRL strategy use for the courses. Six one-way repeated-measures ANOVAs were conducted with the within-subject factor to determine whether there were overall differences in the means among the four WBPT categories for each of the six processes of self-regulation. Wilks' Lambda multivariate test was used, whereby difference scores are calculated by comparing scores from distinct levels of the within-subject factor. Six pairwise comparisons were conducted to examine which SRL processes of each of the four categories of WBPT were supported.

The results indicated that goal setting was primarily supported by collaborative and communication tools as well as by content creation and delivery tools. Task strategies were reported most useful through content creation and delivery tools, followed by assessment tools. Administrative tools and assessment tools were most effective for self-monitoring. Self-evaluation was most supported by administrative tools and assessment tools, followed by content creation and delivery tools. Time planning and management was most effectively supported by administrative tools and collaborative and communication tools. Administrative tools followed by collaborative and communication tools and content creation and delivery tools primarily supported help-seeking student behaviors. The qualitative analyses revealed that content creation and delivery tools, followed by collaborative and communication tools, were most useful in supporting completion of assignments. The results of this study provide a useful framework for thinking about how SRL strategy use can be supported using CMS tools in distributed learning contexts.

Summit Learning and Blended Learning

Summit Learning (2017) is a model with potential to reach the blended learning goals set forth by ESSA by empowering all learners and personalizing classrooms for students to reach their full potential. The Summit Learning platform, implemented in over 380 schools nationwide, is reaching education partners in both the public-school sector as well as the private-school sector. The widespread implementation of the blended learning platform had its beginnings in 2003 with Summit Preparatory Charter High School, in California.

The charter school operated on the belief that all students from all demographic backgrounds could succeed in school given the right environment and experiences that contribute to equipping students for success beyond high school. By 2011, the Summit high school had achieved a measure of success with nearly 100% of their graduates being accepted to at least one four-year university; however, a better outcome became the central focus with only 55% on track to complete college within six years. The Summit team began reinventing the educational experience of their students to include skills necessary for success beyond academic content knowledge, expanding their program to include habits of success and self-directed learning. The classroom teachers across the nation provide valuable feedback, which is utilized to improve the features of the program and learning platform.

Four constructs of learning that emerged through research conducted by Summit Learning define the measurable student outcomes: (a) cognitive skills, (b) content knowledge, (c) habits of success, and (d) sense of purpose. Summit Learning (2017) defines cognitive skills as higher-order thinking skills that cross all disciplines. Habits of success are defined as the non-academic skills necessary for students to self-regulate their learning and are sometimes referred to as soft skills (Duckworth & Yeager, 2015; Summit Learning, 2017). Sense of purpose is defined as the relationships, self-direction, and values necessary for success in the classroom (Summit Learning, 2017). Measuring student outcomes is an integral part of the Summit Learning platform developed for this blended learning model of instruction. A student's grade within the Summit classroom is cognitive skills development (70%) and focus area development (30%), where the soft skills measures are qualitative and mentored by the teacher.

Facebook partnered with Summit learning in 2014 to help build a learning platform to be shared nationwide free of charge. Since the inception of the Summit Learning Platform, approximately 72,000 students in 40 states are currently learning in the blended learning environment. The platform houses the articulated curriculum vertically aligned from grades 4 through 12, including focus areas to develop procedural skills and concept units or projects to develop conceptual understanding. The teacher dashboard provides measurable outcomes that contribute to student development across the four pillars and provide actionable data for teachers to make informed decisions that support individual student development toward course goals. In real time, teachers use the dashboard to make informed decisions about how to address individual student needs toward mastery of conceptual development as well as procedural fluency to support the learning of all students. The Summit Learning platform provides a place for curated materials, giving students choice in how they learn content, and provides teachers the data to facilitate learning, minimizing the chance that students will be left behind in a Summit Learning classroom. Several case studies have been published regarding successful implementation of the model: (a) Woonsocket Middle School, (b) Blackstone Valley Prep High School, and (c) Aspen Valley Prep.

Summit learning and Woonsocket School District. Faggella (2018a) reported on the impact of first-year implementation of Summit learning on grade 8 learners at Woonsocket Middle School, in Woonsocket, Rhode Island. This is a small, urban school district serving approximately 6,000 students with a demographic composition of 73% economically disadvantaged, 9% English learners, and 25% receiving special education services. The state took over the district in 2013 and brought in a new superintendent who recognized students were not graduating post-secondary ready. In 2016-2017, Summit learning was launched with 110 grade 8 students with five implementing teachers. In year one of implementation the grade 8 Summit learning students outperformed their non-Summit learning peers on the *Partnership for Assessment of Readiness for College and Careers* (PARCC). Approximately 21% of Summit learning grade 8 students met or exceeded mathematics proficiency on PARCC, compared with only 11% of non-Summit learning grade 8 peers.

Summit learning and Blackstone Valley Prep High School. A case study was reported by Faggella (2018b) investigating how mentoring sets students on a path to college readiness. The population for the study was Blackstone Valley Prep High School (BVPHS), in Cumberland, Rhode Island. The public charter school serves 330 students in grades 9 through 12, with 63% economically disadvantaged, 12% English learners, and

14% receiving special education services. Influenced by the success of Summit Prep in Redwood City, California, the leadership at BVPHS implemented Summit learning in 2015-2016 to 200 grade 9 and grade 10 students and continued adding grade levels during the subsequent years of implementation. Two years after implementation, BVPHS grade 11 students were 91% more likely to be college and career ready in both literacy and mathematics than their Rhode Island peers with similar demographics. The BVPHS Summit learning students scored 108 points above the state average on the *Scholastic Aptitude Test* (SAT), with qualitative evidence linking the success to the focus on mentoring every scholar.

Summit learning and Aspen Valley Prep. McNeil (2018) reported on a case study conducted at Aspen Valley Prep (AVP), in Fresno, California, serving a student population of 200 grade 4 through grade 8 students. The demographic profile of the charter school included 82% economically disadvantaged, 11% English learners, and 8% receiving special education services. AVP faculty implemented personalized learning for some of their students prior to implementing Summit learning. Impressive differences were evident with the support the initial cohort of students received with the personalized learning plans, such that the administration sought to expand the program for all middle school students facing the challenge of how to manage the program. In 2016-2017, Summit learning implementation managed the personalization of all middle school students at AVP. After one year of implementation, students across all grade levels showed growth (19% proficient to 30% proficient) on *California's Smarter Balanced Test* (CAASPP) and the achievement gap between students who were far below grade level were closer to grade-level expectation (90% distance to grade-level expectation to 51% distance to grade-level expectation). The faculty at Aspen Valley Prep found the

Summit learning platform to be a tool that could efficiently track student personalized learning plans.

The potential exists for Summit Learning to eliminate the mathematics achievement gap and increase the number of students' post-secondary ready in mathematics by incorporating research-based strategies promoting equity for all students. Personalized learning plans implemented within the blended learning environment is a tool influencing student success across the nation, as evidenced through multiple Summit Learning case studies reporting student success.

Summary of Findings

The shift toward increasing mathematics learning is promising in a personalized-learning classroom where students self-regulate, engage, and achieve in mathematics at levels preparing them to be post-secondary ready in the subject. "Personalization (of learning) essentially does away with the factory model of education" (Basham et al., 2016, p. 127). The review of literature identifies the need to develop mathematics conceptually to produce post-secondary ready learners (Houser & An, 2015). Royster et al. (2015) articulated the need to reach learners early to increase the number who are post-secondary ready in mathematics. It is more difficult to accelerate learning the closer a student is to graduation, increasing the need to early-identify students who are on track for post-secondary readiness in mathematics.

One way to increase post-secondary readiness in mathematics is by improving mathematics achievement among all student groups. A race gap has been found to exist, exposing a significant gap in achievement by race/ethnicity (Brown-Jeffy, 2009). Finding an instructional model that eradicates the race gap in crucial to ensuring all students have equal opportunities to achieve in mathematics. A mathematics opportunity gap was found by Spielhagen (2006) whereby the doors to more rigorous mathematics courses were closed for some students exhibiting the same entry credentials, erasing the opportunity for those students to excel at the highest levels of mathematics achievement afforded to other students. Students who are not identified as gifted in mathematics are found to hold a fixed mindset toward mathematics achievement that is detrimental to mathematics success (Hwang et al., 2016). Increasing student self-efficacy through opportunities in mathematics learning has the potential to close the achievement gap, providing for more equitable experiences in the classroom. Utilizing blended learning to address the individual needs of students through personalization of the learning experience can potentially be the answer educators are looking for to address the mathematics achievement gap.

Our nation has been at risk for far too long, and the time is now to identify and define the best practices for engaging students in highly complex mathematics problems through blended learning, where personalization can occur for all learners. Blended learning has been shown to increase graduation rates (Henry, 2018). Basham et al. (2016) found that students assumed an active role in learning when exposed to blended learning environments – a pivot away from the role students assume in the traditional classroom. The technological tools found to be most useful for learning were content creation and delivery tools followed by collaborative and communication tools (Dabbagh & Kitsantas, 2005). Learning from the research and applying the results to inform decisions regarding implementation of blended learning can potentially impact future learning as educators strive to reach all learners in the 21st century classroom. This study examined the influence of blended learning (as a model to personalize learning) on post-secondary readiness and academic achievement in mathematics and has contributed to the literature influencing implementation of blended learning models across the state of Texas and could potentially influence instructional change across the United States.

Theoretical Framework

An educational goal of the blended learning model of instruction is to personalize the learning experience for all students to ensure that graduates demonstrate competence in four domains: (a) higher-order thinking skills, (b) rigorous content knowledge, (c) habits of success consisting of mindsets and dispositions, and (d) sense of purpose consisting of self-efficacy, building relationships, and developing a clear path for the future (Summit Learning, 2017). According to the National Research Council (2012), "the committee identified three domains of competence: cognitive, intrapersonal, and interpersonal. These three domains represent distinct facets of human thinking and build on previous efforts to identify and organize dimensions of human behavior" (p. 21). Conley and French (2014) define student ownership of learning as a key component of college readiness. "The ownership element includes five major components: motivation and engagement, metacognition, goal orientation and self-direction, self-efficacy and self-confidence, metacognition and self-monitoring, and persistence" (Conley & French, 2014, p. 1020). Students need to recognize the importance of studying mathematics and to adopt the belief that through resolve and effort they are capable of learning mathematics (NCTM, 2014).

The variables listed here by multiple researchers represent the framework for learning within the blended learning model of instruction. This framework is rooted in the theory of constructivism – both cognitive constructivism and social constructivism. Both terms are commonly found in literature with many definitions; but it is important to consider the coaction between the development of the thinking individual and the development of the interpersonal and intrapersonal skills instead of focusing on one or the other (Fosnot, 2005). Students in the blended learning classroom where personalization of the learning path is priority are exposed to rigorous content knowledge through application and discovery. They develop habits of success and sense of purpose by goal setting, analysis of their learning path, and peer collaboration. Teachers in the blended learning classroom assume a mentoring role, positioning each student at the center of learning and personalizing each journey to meet the needs of every student. Students at the center of learning construct knowledge through cognitive competence and social competence to achieve academic success – placing theory as the central theme in the actions evidenced in the blended learning classroom.

Conclusion

Personalization through blended learning in mathematics holds promise as an instructional practice to increase post-secondary readiness and achievement in mathematics, emphasizing learning beyond content knowledge. The review of literature serves as a foundation to support the constructs of this study, including information regarding (a) mathematics post-secondary readiness, (b) mathematics academic achievement, and (c) blended learning. The following chapter on methodology will identify the research strategies to be used during this study.

CHAPTER III:

METHODOLOGY

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics. The blended learning students from a large urban school district in the southeast region of Texas were individually matched to traditional students from the same school district to examine the influence of blended learning on post-secondary readiness in mathematics using archived PSAT data and archived STAAR data collected from district records. Additionally, a purposeful sample of high school blended-learning teachers were solicited to participate in the interviews and classroom observations. Quantitative data were analyzed using independent t-tests, Chi-square test of Independence, cross tabulations, and paired samples t-test, while qualitative data were analyzed using an inductive coding process. This chapter presents an overview of the research problem, operational definitions of the theoretical constructs, the purpose of the research and the corresponding research questions, the research design, the population and sampling of the participants, instrumentation, how the data were collected and analyzed, ethical considerations, and the limitations of the study.

Overview of the Research Problem

Much research exists defining a mathematics achievement gap in the United States over the past several decades (Brown-Jeffy, 2009; Evans, 2005; Flores, 2007; NCES, 2015b; OECD, 2016; Spielhagen, 2006). Flores (2007) defines mathematics achievement as an opportunity gap. An opportunity gap is present when equitable experiences are not provided to all students within the mathematics classroom. The gap also exists when students are provided unequitable opportunities to advance to the highest levels of mathematics curricula. Mathematics educators continue to debate a dichotomy in mathematics pedagogy between conceptual understanding and procedural fluency (Larson & Kanold, 2016) – a pedagogical war that impedes the learning process and undermines student achievement. The researcher hopes to expose the integration of procedural fluency and conceptual development through a blended learning model of instruction, in which student voice and choice plays a significant role in student learning with embedded structures for conceptual development and procedural fluency. This innovative approach to learning personalizes a path for students to navigate toward mastery of the course content – both conceptually and procedurally. The blended learning model provides an equal opportunity for all students to master all content with the teacher posited as the guide on the side instead of the sage on the stage, thus minimizing any biases toward achievement and providing for a more equitable classroom experience.

Operationalization of Theoretical Constructs

This study consisted of three constructs: (a) blended learning instructional model, (b) mathematics post-secondary readiness, and (c) student mathematics achievement. Blended learning was defined as an instructional model that included computer-based personalized learning time, teacher-facilitated concept unit time, and individual student/teacher mentor time (Summit Learning, 2017). Student mathematics post-secondary readiness was defined as the level of proficiency obtained on the *Preliminary Scholastic Aptitude Test* (PSAT). According to College Board (2017), grade-level benchmarks can predict whether students are on track for post-secondary readiness. Individual high school grade levels have defined progress measures indicating the quality of a student score and measures performance toward post-secondary readiness on the *Scholastic Aptitude Test* (SAT®). The college and career performance benchmarks are defined by College Board (2017) in Table 1 and was measured using archived PSAT data.

Table 1

Mathematics Performance Benchmarks by Grade

Suite of Assessments Benchmark	Did not meet	Approaching	Meets
SAT College and Career Readiness Benchmark	200-500	510-520	530-800
PSAT 11th-grade Benchmark	160-470	480-500	510-760
PSAT 10th-grade Benchmark	160-440	450-470	480-760
PSAT 9th-grade Benchmark	120-420	430-440	450-720

Note. Performance benchmarks retrieved from College Board (2017).

Student mathematics achievement was defined as a measure of student success on an end-of-course exam. Mathematics student achievement was measured using State of Texas Assessment of Academic Readiness (STAAR) Algebra I End-of-Course (EOC). For the purposes of this study, only first administration scores were considered when measuring mathematics achievement. A passing score on STAAR Algebra I EOC was required for graduation in Texas (TEA, 2018b), and most students demonstrate their knowledge on this exam at the end of the freshman year in high school. The STAAR performance levels in Table 2 are defined by TEA and were measured using archived STAAR data.

Table 2

Mathematics Achievement by Performance Level on STAAR Algebra I EOC

Performance Level	Mathematics Scale Score
Masters grade-level	4333-6100
Meets grade-level	4000-4294
Approaches grade-level	3550-3970
Does not meet grade-level	1406-3500

Note. Performance levels retrieved from Texas Education Agency (2017).

Research Purpose, Questions, and Hypotheses

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics. This study addressed the following research questions:

1. Does participation in blended learning influence post-secondary readiness in mathematics?

   H_o: Blended learning participation does not influence post-secondary readiness in mathematics.

   H_a: Blended learning participation does influence post-secondary readiness in mathematics.

2. Is there a relationship between blended learning participation and post-secondary readiness?

   H_o: There is no relationship between blended learning participation and post-secondary readiness.

   H_a: There is a relationship between blended learning participation and post-secondary readiness.

3. Is there a statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018?

   H_o: There is no statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018.

   H_a: There is no statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018.

4. Does participation in blended learning influence academic achievement in mathematics?

   H_o: Blended learning participation does not influence academic achievement in mathematics.

   H_a: Blended learning participation does influence academic achievement in mathematics.

5. Is there a relationship between blended learning participation and mathematics achievement?

   H_o: There is no relationship between blended learning participation and mathematics achievement.

   H_a: There is a relationship between blended learning participation and mathematics achievement.

6. What are the observable and teacher perceived characteristics of the blended learning classroom?

Research Design

The research design for this study was a sequential mixed-methods approach (QUAN→qual). According to Johnson and Onwuegbuzie (2004), mixed methods "is inclusive, pluralistic, and complementary and it suggests that researchers take an eclectic approach to method selection" (p. 17). This design consisted of two phases: first, a quantitative phase, and second, a qualitative phase. The advantage to a mixed-methods approach is to allow for a more robust exploration of the quantitative data through descriptive analysis of the qualitative data. Blended learning students from a large urban school district in the southeast region of Texas were individually matched to traditional students from the same school district to examine the influence of blended learning on post-secondary readiness in mathematics using archived PSAT data and archived STAAR data collected from district records. Additionally, a purposeful sample of high school blended-learning teachers were solicited to participate in the interviews and classroom observations. Quantitative data were analyzed using independent t-tests, Chi-square test of Independence, cross tabulations, and paired samples t-test while qualitative data were analyzed using an inductive coding process.

Population and Sample

The population for this study was a large urban school district located in the southeast region of Texas with a student population of approximately 54,520 for the school year 2017-2018, with 3,571 representing the sophomore cohort. The school district was composed of six high schools, 10 intermediate schools, 11 middle schools, 36 elementary schools, and four alternative campuses. The district's demographic profile consists of 83.0% Hispanic, 7.5% African American, 5.7% Caucasian, 3.0% Asian, and 0.8% other, with 76.6% of the students being economically disadvantaged. Of the students described above, 28.7% are English learners (EL), and 9.8% receive special education (SPED) services. The demographics for the participating district were summarized and reported in Table 3.

Table 3

Participating District Demographics

	Frequency (*n*)	Percentage (%)
1. Total students	54,520	100.0
2. Gender		
Male	28,078	51.5
Female	26,422	48.5
3. Race/Ethnicity		
African American	4,089	7.5
Asian	1,635	3.0
Caucasian	3,108	5.7
Hispanic	45,252	83.0
Other	436	0.8
4. Special Populations		
Economically disadvantaged	41,762	76.6
English learners	15,637	28.7
Special education	5,343	9.8

Note. Demographic information retrieved from Texas Education Agency (2018c).

Five of the six high schools in the district implemented the blended learning model of instruction for a small cohort of students on each campus; but only three campuses with a sophomore cohort were considered for the study. The two campuses not considered for participation in the study were in their first year of implementation with only freshman students participating in blended learning. Archived data for the 10th-grade district cohort were analyzed to determine the influence of blended learning on post-secondary readiness and academic achievement in mathematics. The population demographics for the three participating high schools were summarized in Table 4.

Table 4

Implementing High Schools in Participating District

	Frequency (*n*)	Percentage (%)
1. Site A		
Total Students	4,194	100.0
Gender		
Male	2,168	51.7
Female	2,026	48.3
Race/Ethnicity		
African American	704	16.8
Asian	418	10.0
Caucasian	251	6.0
Hispanic	2,763	65.9
Other	58	1.4
Special Populations		
Economically disadvantaged	2,420	57.7
English learners	297	7.1
Special Education	335	8.0
2. Site B		
Total Students	1,406	100.0
Gender		
Male	693	49.3
Female	713	50.7
Race/Ethnicity		
African American	40	2.8
Asian	33	2.3
Caucasian	122	8.7
Hispanic	1,202	85.5
Other	9	0.7
Special Populations		
Economically disadvantaged	935	73.8
English learners	746	58.9
Special education	137	10.8

Note: Demographic information retrieved from Texas Education Agency (2018c) and district repositories.

(continued)

Table 4

Implementing High Schools in Participating District (cont.)

	Frequency (*n*)	Percentage (%)
3. Site C		
Total Students	2,892	100.0
Gender		
Male	1,501	51.9
Female	1,391	48.1
Race/Ethnicity		
African American	260	9.0
Asian	23	0.8
Caucasian	64	2.2
Hispanic	2,536	87.7
Other	9	0.3
Special Populations		
Economically disadvantaged	2,192	75.8
English learners	492	17.0
Special education	341	11.8

Note: Demographic information retrieved from Texas Education Agency (2018c) and district repositories.

The samples used for this study were individually matched on the following variables: (a) gender, (b) race/ethnicity, (c) economically disadvantaged, (d) English learner, and (e) special education. Students participating in the blended learning model of instruction framed the purposive sample for this study. Inclusion in the study meant that each blended learning student had the following archived scores: (a) STAAR EOC, (b) PSAT 2017, and (c) PSAT 2018. All students were included in the sample who had all three scores in archived data and then those students were individually matched using demographic data for the participating high schools. When the students in the sampling frame provided unequal numbers in traditional instruction and blended learning instruction, then a random sample was chosen from the sampling frame for the for the participant sample. Of the 84 students in Site A's sample, 42 of them participate in blended learning with 20 (47.6%) males and 22 (52.4%) females. Race/ethnicity of Site A's sample included 12 (28.6%) African American, one (2.4%) Asian, 26 (61.9%) Hispanic, and three (7.1%) other with 33 (78.6%) economically disadvantaged and one (2.4%) receiving special education services (see Table 5).

Table 5

Matched Sample for Site A

	Blended learning sample		Traditional sample	
	Frequency (*n*)	Percentage (%)	Frequency (*n*)	Percentage (%)
1. Total students	42	100.0	42	100.0
2. Gender				
Male	20	47.6	20	47.6
Female	22	52.4	22	52.4
3. Race/Ethnicity				
African American	12	28.6	12	28.6
Asian	1	2.4	1	2.4
Caucasian	0	0.0	0	0.0
Hispanic	26	61.9	26	61.9
Other	3	7.1	3	7.1
4. Special Populations				
Economically disadvantaged	33	78.6	33	78.6
English learners	0	0.0	0	0.0
Special education	1	2.4	1	2.4

Note. Demographic information retrieved from district repositories.

Site B's total student sample was 150, with 75 participating in blended learning and 75 participating in traditional instruction. Of the 75 participating in blended learning, 35 (46.7%) were male and 40 (53.4%) were female. Race/ethnicity of Site B's blended learning sample included one (1.3%) African American, three (4.0%) Caucasian, and 71 (94.7%) Hispanic with 67 (89.3%) economically disadvantaged, 10 (13.3%) English learners, and three (4.0%) receiving special education services. The demographics of the matched sample for Site B were summarized in Table 6 below.

Table 6

Matched Sample for Site B

	Blended learning sample		Traditional sample	
	Frequency (*n*)	Percentage (%)	Frequency (*n*)	Percentage (%)
1. Total students	75	100.0	75	100.0
2. Gender				
Male	35	46.7	20	46.7
Female	40	53.3	40	53.3
3. Race/Ethnicity				
African American	1	1.3	1	1.3
Asian	0	0.0	0	0.0
Caucasian	3	6.5	3	6.5
Hispanic	71	94.7	71	94.7
Other	0	0.0	0	0.0
4. Special Populations				
Economically disadvantaged	67	89.3	67	89.3
English learners	10	13.3	10	13.3
Special education	3	4.0	3	4.0

Note. Demographic information retrieved from district repositories.

Site C's total student sample was 138, with 69 participating in blended learning and 69 participating in traditional instruction. Of the 69 participating in blended learning, 35 (50.7%) were male and 34 (49.3%) were female. Race/ethnicity of Site C's blended learning sample included two (2.9%) African Americans and 67 (97.1%) Hispanics with 65 (94.2%) economically disadvantaged, 18 (26.1%) English learners, and one (1.4%) receiving special education services (see Table 7).

Table 7

Matched Sample for Site C

	Blended learning sample		Traditional sample	
	Frequency (*n*)	Percentage (%)	Frequency (*n*)	Percentage (%)
1. Total students	69	100.0	69	100.0
2. Gender				
Male	35	50.7	35	50.7
Female	34	49.3	34	49.3
3. Race/Ethnicity				
African American	2	2.9	2	2.9
Asian	0	0.0	0	0.0
Caucasian	0	0.0	0	0.0
Hispanic	67	97.1	67	97.1
Other	0	0.0	0	0.0
4. Special Populations				
Economically disadvantaged	65	94.2	65	94.2
English learners	18	26.1	18	26.1
Special education	1	1.4	1	1.4

Note. Demographic information retrieved from district repositories.

Participant Selection

A purposeful sample of high school teachers implementing blended learning instruction working in high schools located in a large urban school district in the southeast region of Texas were sent an email soliciting participation in interviews and classroom observations. Blended learning teachers who teach high school Algebra I, Geometry, or Algebra II were considered as part of the sampling frame but to triangulate data only Geometry teachers at the participating sites were considered for the sample. Of the Geometry teachers implementing the blended learning instruction, one has 10 years teaching experience, one has four years teaching experience, one has three years teaching experience, and one teacher has two year of classroom experience. One teacher was Asian and three were Caucasian. Of the four participating teachers, three were male and one was female. Table 8 provides the participating teacher demographics.

Table 8

Participating Blended Learning Teacher Demographics

	Frequencies (n)	Percentages (%)
1. Gender		
Male	3	75.0
Female	1	25.0
2. Race/Ethnicity		
Asian	1	25.0
Caucasian	3	75.0
3. Teaching Experience		
Traditional Classroom		
0-2 Years	1	25.0
3-5 Years	2	50.0
6-9 Years	1	25.0
Blended Classroom		
0-2 Years	3	75.0
3-5 Years	1	25.0

Note: Demographic information provided by participants during interviews.

Instrumentation

PSAT Mathematics

A pre-existing assessment for college readiness, the *Preliminary Scholastic Aptitude Test* (PSAT), was used to measure post-secondary readiness in mathematics. The College Board Suite of Assessments focus on what research shows is most important for college and career readiness. The associated set of metrics for mathematics indicates a student has a 75% likelihood of earning a C or better during their first year of college in a credit-bearing mathematics course (College Board, 2017). According to College Board (2017), a 10th-grade mathematics benchmark of 480 indicates that a student is on track to score a required minimum of 530 on the mathematics portion of the test to be exempt from remedial, non-credit bearing courses and be designated post-secondary ready. The PSAT assesses student performance over four content domains: (a) heart of algebra, (b) problem solving and data analysis, (c) passport to advanced mathematics, and (d) additional topic in mathematics.

STAAR Algebra I End-of-Course Assessment

A pre-existing assessment for academic achievement, the *State of Texas Assessment of Academic Readiness* (STAAR), was used to determine academic achievement in mathematics. The Texas legislature called for a new set of assessments that increased in rigor and assessed post-secondary readiness. "Consistent with a growing national consensus regarding the need to provide a more clearly articulated K-16 education program, STAAR focuses on fewer skills and addresses those skills in a deeper manner" (TEA, 2013, p. 5). The STAAR assessments are administered to students in two subjects (reading and mathematics) each year from grade 3 through grade 8 and then again in high school as end-of-course examinations. Other subjects are assessed at pre-determined years, such as writing in grades 4, 7, and end-of-course; science in grades 5, 8, and biology end-of-course; and social studies in grade 8 and U.S. history end-of-course. For this study, 2017 STAAR Algebra I EOC was collected for a cohort of students in the participating district to determine academic achievement in mathematics.

State of Texas Assessment of Academic Readiness (STAAR) assessments were scaled using "an item response theory model known as Rasch Partial-Credit Model (RPCM)" (TEA, 2013, p. 17). Vertical scaling and horizontal scaling of the STAAR assessment items were conducted to ensure consistency across grade levels. Texas Education Agency conducted STAAR linking studies to inform performance standards alignment across assessments increasing construct validity. Content validity also increases through vertical standards alignment ensuring developed items are assessing students on grade level standards with a team of experts reviewing each assessment item. The correlation between STAAR Algebra I EOC and STAAR Algebra II EOC was determined to be 0.68, indicating the strength of the relationship between the assessments. Reliability was estimated using a method that requires only one test administration to reduce the assessment burden on students. The Kuder-Richardson 20 (KR_{20}) was used to determine the reliability of the mathematics tests, where a result of 0.70 to 0.79 was considered adequate, 0.80 to 0.89 was considered good, and greater than or equal to 0.90 was considered excellent. The KR_{20} result for the *STAAR Algebra I End-of-Course* was 0.924 determining the reliability of the assessment to be excellent (TEA, 2016).

All items on the *STAAR Algebra I End-of-Course* are subject to a rigorous review process to ensure the items of the assessment are measuring the *Texas Essential Knowledges and Skills* (TEKS). Contract reviewers, TEA reviewers, and item review committees independently review the items before the items are included on an assessment and field tested. Data were reviewed for each field test item to determine any biases before the items are accepted or rejected. Accepted items then were placed in an item bank to be used in test construction.

Data Collection Procedures

Quantitative

The researcher obtained permission to conduct the study from the University of Houston-Clear Lake (UHCL) Committee for the Protection of Human Subjects (CPHS) and the participating school district's Institutional Review Board (IRB) before collecting data. The researcher collected data from an archived database with the assistance of the participating school district's research and evaluation department. Data from PSAT 2017 and PSAT 2018 scores related to participants were requested from the research and evaluation department as well as STAAR Algebra I EOC 2017 scores related to participants.

Qualitative

After permission was granted from CPHS and the district's IRB, the researcher solicited the names and email addresses of the blended learning teachers at the participating high schools from the research and accountability department within the participating school district. The mathematics teachers assigned to work with students in the blended learning model at the five participating high schools were sent an email requesting their participation in the study and to be observed during class time as well as to participate in individual interviews. The email contained the purpose of the study, stated participation in the study to be strictly voluntary, and communicated that identities were to remain anonymous.

Observations. The researcher elicited the assistance of the mathematics campus content specialist at each participating campus to co-observe classroom structures within the blended learning environment. Blended learning class schedules were collected from each participating campus to schedule observations of each of the three structures: (a) concept unit development, (b) self-directed learning, and (c) 1:1 mentoring. Calendared events were then scheduled during the 2018 fall semester to observe each structure twice at each of the participating campuses. Data were collected through an observation protocol, calibrated for inter-rater reliability, and then transcribed by the researcher. When the team piloted the observational instrument, the decision was made to create three outcome categories for collecting data: evidence, missed opportunity, and not observed. "Evidence" was defined as a clear implementation of the key criteria demonstrated during the observation. "Missed opportunity" was defined as a clear opportunity for the key criteria to be evident; but the teacher and/or student did not act upon the opportunity. "Not observed" was defined as an opportunity not presented for either the teacher or student to act upon; therefore, is was not a missed opportunity, but rather not observed. The three categories of outcomes remained consistent for all three structures during the study.

Both the researcher and the campus content specialist recorded field notes during all observations to support the data collected on the observation protocol. Participating campus content specialists analyzed transcriptions of both the observations and field notes to ensure the interpretation represented the observation with fidelity. Picture evidence during observations was also documented to show the flexible seating utilized in blended learning classrooms. The pictures were then used to create diagrams and identify common seating found across classroom observations: (a) content assessment zones, (b) self-directed learning zones, (c) small group zones, and (d) teacher center. The diagrams were used to support the differences between the blended learning classroom and the traditional classroom.

Interviews. A semi-structured 30-minute interview was scheduled during the 2018 fall semester with each of the implementing teachers to gather evidence from the teachers' perspective regarding their experiences in the blended learning classroom. The interviews, with participant permission, were audio recorded and automatically transcribed using Google's voice typing tool. A technical assistant was used to follow along with the Google transcription and to notate anywhere the transcription misrepresented the words spoken during the interview. The researcher then validated the transcription using the audio recording of the interview and the assistant's notes before sending the transcripts to the participant for member checking. The researcher retained a digital archive of the audio recording and transcription, and a flash drive containing the stored data was locked in a safe in a storage room to remain for five years before being destroyed.

Data Analysis

Quantitative

All quantitative data obtained were uploaded into IBM Statistical Package for the Social Sciences (SPSS) for further analysis. To establish baseline equivalence, an independent t-test was conducted on PSAT 2017. High school students participated in the PSAT 2017 during October of their freshman year. The independent variable, instructional models was divided into two categorical groups: (a) blended learning model of instruction and (b) traditional model of instruction. The dependent variable or outcome measure, PSAT score, was a continuous variable. Effect size was assessed using Cohen's d and coefficient of determination (r^2).

Post-secondary readiness. Research question one was answered using an independent t-test to examine the influence of the blended learning model of instruction on post-secondary readiness in mathematics. The independent variable, instructional models, was divided into two categorical groups: (a) blended learning model of instructional and (b) traditional model of instruction. The dependent variable or outcome measure, PSAT score, was a continuous variable. Effect size was assessed using Cohen's d and coefficient of determination (r^2).

Research question two was answered using Chi-square test of Independence and cross tabulations to determine if there is a relationship between blended learning participation and post-secondary readiness. According to College Board (2017), if a 10th-grade student scores between 480 and 760 on PSAT math then a student meets grade-level expectations. If a student scores 450-470 on PSAT math, then the student is approaching grade-level expectations and if a student scores 160-440 on PSAT math, the student is far below grade-level expectation. The demographic information was analyzed for gender, race/ethnicity, and special populations, all of which are categorical variables. The outcome measure, PSAT benchmark, will also be a categorical variable.

Research question three was answered using a paired samples t-test to examine the statistical significance of the mean differences between PSAT 2017 and PSAT 2018 of the blended learning model of instruction participants. The independent variable, instructional model, contained one categorical group- blended learning model of instructional. The dependent variable or outcome measure was paired: (a) PSAT 2017 and (b) PSAT 2018 to determine if the mean difference between scores was statistically significant. Effect size was assessed using Cohen's d and coefficient of determination (r^2).

Academic Achievement. Research question four was answered using an independent t-test to examine the influence of the blended learning model of instruction on academic achievement in mathematics. The independent variable, instructional models, was divided into two categorical groups: (a) blended learning model of instructional and (b) traditional model of instruction. The dependent variable or outcome measure, STAAR Algebra I EOC, was a continuous variable. Effect size was assessed using Cohen's d and coefficient of determination (r^2).

Research question five was answered using Chi-square test of Independence and cross tabulations to determine if there is a relationship between blended learning participation and mathematics achievement. According to TEA (2017), if a student scores between 4333 and 6123 on STAAR Algebra I EOC, the student has mastered grade-level content and is considered well prepared for the next course. If a student scores from 4000 to 4267 on STAAR Algebra I EOC, the student meets grade-level content and is considered prepared for the next course. If a student scores 3550-3951 on STAAR Algebra I EOC, then the student approaches grade-level content and is not considered prepared for the next course without remediation. If a student scores 1394-3520 on STAAR Algebra I EOC, then the student did not meet grade level content and is not likely to succeed in the next course. The demographic information was analyzed for gender, race/ethnicity, and special populations, all of which are categorical variables. The outcome measure, STAAR performance level, was a categorical variable. A statistical significance of 0.05 was used for this study.

Qualitative

To investigate research question six, an inductive coding process was utilized to address the interview responses of the participants. Identification of key themes and patterns organized and managed interview responses into meaningful data. As repeated themes emerged, they were grouped into categories and coded using the following themes: (a) teacher as facilitator, (b) teacher as mentor, (c) personalized learning, and (d) blended learning. The interview data supported the observational data collected based on implemented structure: (a) 1:1 Mentor Check-in, (b) math concept unit, and (c) self-directed learning (SDL). The interview data and observation data were then interpreted and presented to paint a picture of the difference between the blended learning mathematics classroom and the traditional mathematics classroom. This information, along with the findings from the quantitative data, provide a rich understanding of the blended learning classroom environment and vivid description of the differences between the blended learning mathematics classroom and the traditional mathematics classroom.

Qualitative Validity

The qualitative analysis process involved validation by using respondent validation. The preliminary responses to the interview questions were member-checked by the participants to enhance the validity of the responses provided. Data obtained from the interviews, classroom observations, and artifacts were compared and cross-checked among implementing campuses exposing consistent characteristics in the blended learning instructional environments. The interview questions were peer reviewed by experienced educators, including district-level administrators, to ensure the validity of the questions. Participants member-checked the interview transcriptions to verify they equaled the intent of the participant and edited as requested by the participants. District-level campus content coaches used the classroom observation tool and the results were calibrated across all campus coaches to ensure validity of the observational data. Field notes were interpreted by the researcher and member-checked by the campus coach to ensure validity of the interpretation. To increase validity, observational data were compared across all participating campuses and discussed to ensure all observers recorded data consistently per structure.

Privacy and Ethical Considerations

The researcher obtained permission to conduct the study from the UHCL's CPHS and the participating school district's IRB prior to collecting data. No names identifying the school district, schools, teachers, coaches, or student participants were mentioned in the study. The researcher used alpha-numeric codes to label data collected to protect the identity of the participants. An interview and observation cover letter were included in the email sent to the teachers ensuring the participants were aware that participation was voluntary and that their identities and responses would remain confidential. Each participant was asked to sign a consent form that stated the purpose and procedures of the study, the expected duration of the study, the risk of participation, any benefits to the participant, confidentiality of records, financial compensation, the right to withdraw, and provided contact information for questions or problems. Data collected for the study was stored on a removable drive and will remain in locked storage for five years before being destroyed.

Research Design Limitations

There were limitations to this study. First, the blended learning model used as the treatment in the current study was part of Summit Learning, which served a diverse community of schools around the country. At the time of this study, Summit Learning served over 54,000 students in approximately 330 schools, reaching 40 states in the U.S. The researcher focused on one Summit Learning partner district in Texas with three participating high schools for the current study; therefore, the results were only generalizable across the participating Texas district. Second, a history effect limited the study in that a weather phenomenon displaced many students within the district; thus, reducing the number of students from the sample or influencing the scores on PSAT 2017 (which was administered shortly after classes were resumed) following the weather phenomenon.

Third, an interview guide was used with participants for this study. The data collected from the interviews is only as accurate as the participants were willing to engage in communicating openly and honestly influencing a third limitation to the study. Fourth, given the infancy of the blended learning model and the varied experience level of the instructors it was not possible to control for instructor experience level across the implementing campus sites, nor was it possible to control the demographic of the sample.

Conclusion

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning. This chapter has provided an overview of the research problem, operational definitions of the theoretical constructs, the purpose of the research and the corresponding research questions, the research design, the population and sampling of the participants, instrumentation, the way the data were collected and analyzed, ethical considerations, and the limitations of the study. The findings from this research are reported in chapter four.

CHAPTER IV:

RESULTS

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning. This chapter presents the findings of the quantitative and qualitative data analysis of the study. First, an explanation of the participants' demographics of the study are presented, followed by the results for each of the six research questions. The chapter concludes with a summary of the findings.

Participant Demographics

Grade 10 students participating in the blended model of instruction attending the three participating high schools matched with traditional instruction students comprised the sample for the study. The participant sample was individually matched on gender, race/ethnicity, economically disadvantaged status, English learner status, and special education status. Of the 84 students in the Site A sample, 42 students participate in blended learning and 42 participate in traditional learning with 20 (47.6%) males and 22 (52.4%) females in each sample set. Race/ethnicity of the Site A matched sample included 12 (28.6%) African American, one (2.4%) Asian, 26 (61.9%) Hispanic, and three (7.1%) other with 33 (78.6%) economically disadvantaged and one (2.4%) receiving special education services. Of the 42 students participating in traditional instruction, each participant was individually matched on the above demographics. When the population of traditional students outnumbered the blended learning students, then equal numbers of students from the population were chosen at random to construct the individually matched sample (see Table 5 on page 44).

The matched student sample at Site B was 150, with 75 participating in blended learning and 75 participating in traditional instruction. Of the 75 participating in blended learning, 35 (46.7%) were male and 40 (53.4%) were female. Race/ethnicity of the Site B blended learning sample included one (1.3%) African American, three (4.0%) Caucasian, and 71 (94.7%) Hispanic with 67 (89.3%) economically disadvantaged, 10 (13.3%) English learners, and three (4.0%) receiving special education services. Of the 75 participating in traditional instruction, the demographics were first individually matched and then if an unequal number of students in the population existed, then students were chosen at random to create the sample set (see Table 6 on page 45).

The matched student sample at Site C was 138, with 69 participating in blended learning and 69 participating in traditional instruction. Of the 69 participating in blended learning, 35 (50.7%) were male and 34 (49.3%) were female. Race/ethnicity of the Site C blended learning sample included two (2.9%) African American and 67 (97.1%) Hispanic with 65 (94.2%) economically disadvantaged, 18 (26.1%) English learners, and one (1.4%) receiving special education services. Again, the matched sample was created by individually matching on the demographics first and when unequal numbers existed in the population then a random sample was chosen as participants (see Table 7 on page 46).

Blended learning high school Geometry teachers at the three participating sites were also interviewed and observed for the study. Of the four participating teachers, three (75%) were male and one (25%) was female. Race/ethnicity was reported by the participants to be three (75%) Caucasian and one (25%) Asian. Teaching experience of the participating teachers range from nine years' experience to one-year experience with one (25%) reporting 6-9 years' experience, two (50%) with 3-5 years' experience, and one (25%) with 0-2 years' experience. Blended learning experience reported to be four years by one (25%) participant and one year by three (75%) participants (see Table 8 on page 47).

Baseline Equivalence

Baseline equivalence was established using an independent samples t-test with model of instruction as the independent variable and the pre-test measure of PSAT 2017 mathematics score as the dependent variable. The results of the independent samples t-test indicated that model of instruction did not influence post-secondary readiness in mathematics, $t(370) = 0.677$, $p = .499$, with equal variance assumed as measured by PSAT 2017 (see Table 9). Therefore, baseline equivalence was established as the treatment group (blended) and the comparison group (traditional) scored similarly on prior PSAT 2017 performance data.

Table 9

Baseline Equivalence Using PSAT 2017 Scores and Instructional Model

Instruction	N	M	SD	*t*-value	df	*p*-value
1. Traditional	186	387.10	44.70	0.677	370	0.499
2. Blended	186	383.66	52.97			

*Statistically significant ($p < .05$)

Research Question One

Research question one, *Does participation in blended learning influence post-secondary readiness in mathematics?,* was answered using an independent samples t-test with model of instruction as the independent variable and the PSAT 2018 math score as the dependent variable. The independent samples t-test was first conducted by combining participants in all three sites. The results of the independent samples t-test indicated that participation in blended learning did not influence post-secondary readiness in mathematics, $t(370) = 0.613$, $p = 0.540$. In other words, model of instruction did not matter when measuring post-secondary readiness using PSAT 2018 math scores. At the time of the study, students had participated in blended learning for one academic school year and three months into the fall semester of their second academic school year. The process of change for both students and teachers was in its infancy potentially explaining the lack of influence on post-secondary readiness. According to Hall and Hord (1987), change is not an event; but a process that requires time. The results of the independent samples t-test are shown in Table 10.

Table 10

Instructional Influence on Post-Secondary Readiness using PSAT 2018 Scores

Instruction	N	M	SD	*t*-value	df	*p*-value
1. Traditional	186	391.24	63.46	0.613	370	0.540
2. Blended	186	387.53	52.81			

*Statistically significant ($p < .05$)

With three participating high school sites, the influence on post-secondary readiness in mathematics was further investigated by conducting an independent samples t-test on each participating site to determine if the individual sites yielded the same or different results. The results of the independent samples t-test indicated that models of instruction at Site A did not influence post-secondary readiness in mathematics, $t(82) = -.435$, $p = 0.664$. The results of the independent samples t-test for Site B indicated that models of instruction at Site B did not influence post-secondary readiness in mathematics, t(148) = 0.824, p = 0.411. The results of the independent samples t-test for Site C indicated that models of instruction at Site C did not influence post-secondary readiness in mathematics, t(136) = 0.536, p = 0.593. In other words, the results of the individual site analysis were similar to whole group analysis indicating model of instruction did not matter when measuring post-secondary readiness using PSAT 2018 math scores. The results of the independent samples t-test by site are shown in Table 11.

Table 11

Instructional Influence on Post-Secondary Readiness using PSAT 2018 Scores by Site

Instruction	N	M	SD	*t*-value	df	*p*-value
1. Site A						
Traditional	42	377.86	63.46	-0.435	82	0.664
Blended	42	383.57	56.60			
2. Site B						
Traditional	75	408.67	66.42	0.824	148	0.411
Blended	75	400.80	49.29			
3. Site C						
Traditional	69	380.43	56.24	0.536	136	0.593
Blended	69	375.51	51.58			

*Statistically significant (p < .05)

Research Question Two

Research question two, *Is there a relationship between blended learning participation and post-secondary readiness?,* was answered using Chi-Square Test of Independence and cross tabulations with model of instruction and PSAT 2018 grade level benchmark as the categorical variables. The data were analyzed by campus site, race/ethnicity, gender, participation in special education, English learner, and economically disadvantaged to measure the relationship between model of instruction and post-secondary readiness.

Campus Sites

The cross tabulation results are shown in Table 12 for all three participating high schools. The results of the Chi-square test of Independence for the combined campuses indicate no statistically significant relationship existed between model of instruction and post-secondary readiness, χ^2 (2, N = 372) = 1.64, p = .440. In other words, students' post-secondary readiness on PSAT 2018 math was not related to their model of instruction. Results indicated the same percentage of students (6.5%) met grade level performance on PSAT 2018. Approximately 11% of students approaching grade level performance participated in traditional instruction and 7.0% of students approaching grade level performance participated in blended learning instruction. Of the blended learning participants, 86.6% did not meet grade level expectations compared to 82.2% who participated in traditional learning. Again, the infancy of the implementation of blended learning instruction may explain the lack of a relationship between the model of instruction and post-secondary readiness.

Table 12

Cross Tabulation Results of PSAT 2018 Grade Level Benchmark and Instructional Model

Instructional Model	Did Not Meet	Approaching	Meets
1. Traditional	154 (82.8%)	20 (10.8%)	12 (6.5%)
2. Blended	161 (86.6%)	13 (7.0%)	12 (6.5%)

Note. χ^2 = 1.64, df = 2, p = .440.

Investigating the question further by looking at each participating site independently, Chi-square test of Independence and cross tabulations were conducted on each of the three sites individually (see Table 13). The results of the Chi-square test for Independence for Site A indicated no statistically significant relationship between model of instruction and post-secondary readiness, χ^2(2, N = 84) = 5.30, p = .071. In other words, students' post-secondary readiness on PSAT 2018 math was not related to their model of instruction. The results indicated that 9.5% of students met grade level expectations at Site A were in the blended learning classroom and 0% of students were in the traditional classroom; but 11.9% of students were approaching grade level expectation in the traditional classroom with 4.8% of students in the blended learning classroom. Possibly more students met grade level expectation in the blended learning classroom at Site A because of the years of experience of the teacher in the classroom. During observation, the level of expertise demonstrated by the teacher was apparent with the ease in which the teacher addressed content and naturally responded by questioning students rather than telling students information. The Site A teacher was also further along in the stages of change implementing blended learning than the educators at the other sites.

The results for Site B indicated no statistically significant relationship between model of instruction and post-secondary readiness, $\chi^2(2, N = 150) = 2.80$, $p = .246$. In other words, students' post-secondary readiness on PSAT 2018 math was not related to their model of instruction. The cross tabulations indicated that 12.0% of students met grade level expectations at Site B in the traditional classroom and 9.3% of students in the blended learning classroom with 16.0% of students approaching grade level performance in the traditional classroom and 8.0% of students in the blended classroom. Of the students who did not meet grade level performance, 72.0% of students participated in traditional instruction with 82.7% of students who participated in blended instruction. Site B was a demonstration site for others to come and visit and was used as a model campus for implementation of blended learning. During observation it was evident the teacher fully embraces the blended model of instruction as the students fluidly moved between designated learning zones in the classroom. The students took ownership of their learning, as evidenced by the work produced when other students in the room occupied the teacher. The teacher in the blended learning classroom was new to the model so the infancy of the implementation left both the teacher and students amidst the productive struggle exhibited during the process of change and could have had an effect on the results.

The results for Site C also indicated no statistically significant relationship between model of instruction and post-secondary readiness, $\chi^2(2, N = 138) = 1.50$, $p = .472$. In other words, students' post-secondary readiness on PSAT 2018 math was not related to their model of instruction. The cross tabulations indicated 4.3% of students in traditional instruction met grade level performance with 1.4% of students in blended learning instruction; but 4.3% of students were approaching grade level performance in traditional instruction and 7.2% of students in blended learning instruction. Of the students who did not meet grade level expectation, 91.3% of students participated in traditional instruction and 91.3% of students participated in blended instruction. The Site C teacher had the least amount of classroom experience. During classroom observation, relationships between students and teacher were evidently strong; however, setting expectations for learning for each student was an area of growth for the young teacher as classroom practice and expectations were continuing to develop.

Table 13

Cross Tabulation Results of PSAT 2018 Grade Level Benchmark and Instruction by Site

Instructional Model	Did Not Meet	Approaching	Meets
1. Site A			
Traditional	37 (88.1%)	5 (11.9%)	0 (0%)
Blended	36 (85.7%)	2 (4.8%)	4 (9.5%)
2. Site B			
Traditional	54 (72.0%)	12 (16.0%)	9 (12.0%)
Blended	62 (82.7%)	6 (8.0%)	7 (9.3%)
3. Site C			
Traditional	63 (91.3%)	3 (4.3%)	3 (4.3%)
Blended	63 (91.3%)	5 (7.2%)	1 (1.4%)

Note. Site A: χ^2 = 5.30, df = 2, p = .071; Site B: χ^2 = 2.80, df = 2, p = .246; Site C: χ^2 = 1.50, df = 2, p = .472

Regardless of experience of the educator, the results remained consistent across the participating high school sites indicating that the school in which students attended did not yield a different result when determining a relationship between model of instruction and post-secondary readiness. Pockets of promise seemed to be emerging from the data at one site with more students in blended learning meeting grade level expectations; but the overall results were not significant enough to determine if model of instruction was the determining factor in student performance.

Race/Ethnicity

When examining the relationship of race/ethnicity between model of instruction and post-secondary readiness in mathematics, Chi-square test of Independence and cross tabulations were conducted with the models of instruction and PSAT 2018 grade level benchmark as the categorical variables. The size of the sample limited the depth of analysis to whole population with no break out by campus site. The results of the Chi-square test of Independence indicated no statistically significant relationship of race/ethnicity between instructional model and post-secondary readiness in mathematics when measured using PSAT 2018, Caucasian, $\chi^2(1, N = 6) = 1.2, p =.273$; African American, $\chi^2(2, N = 30) = 2.14, p = .343$; Hispanic, $\chi^2(2, N = 328) = 1.61, p =.446$; Asian, $\chi^2(1, N = 2) = 2.0, p = .157$; Other, $\chi^2(1, N = 6) = 1.2, p = .273$. In other words, there is no relationship between one's race/ethnicity within instructional model and post-secondary readiness in mathematics as shown in Table 14.

Table 14

Race/Ethnicity Cross Tabulation Results of PSAT 2018 Grade Level Benchmark by Instruction

Race/Ethnicity	Did not meet	Approaching	Meets
1. Caucasian	5 (83.3%)	1 (16.7%)	n/a
Traditional	2 (66.7%)	1 (33.3%)	n/a
Blended	3 (100.0%)	n/a	n/a
2. African American	28 (93.3%)	1 (3.3%)	1 (3.3%)
Traditional	15 (100.0%)	n/a	n/a
Blended	13 (86.7%)	1 (6.7%)	1 (6.7%)
3. Hispanic	276 (84.1%)	30 (9.1%)	22 (6.7%)
Traditional	134 (81.7%)	18 (11.0%)	12 (7.3%)
Blended	142 (86.6%)	12 (7.3%)	10 (6.1%)
4. Asian	1 (50.0%)	1 (50.0%)	n/a
Traditional	n/a	1 (100%)	n/a
Blended	1 (100.0%)	n/a	n/a
5. Other	5 (83.3%)	n/a	1 (16.7%)
Traditional	3 (100.0%)	n/a	n/a
Blended	2 (66.7%)	n/a	1 (16.7%)

Note. Caucasian, $\chi^2 = 1.2$, df = 1, p = .273; African American, $\chi^2 = 2.1$, df = 2, p = .343; Hispanic, $\chi^2 = 1.6$, df = 2, p = .446; Asian, $\chi^2 = 2.0$, df = 1, p = .157; Other, $\chi^2 = 1.2$, df = 1, p = .273.

The largest race/ethnicity group in the participating district was Hispanic and according to the results, 7.3% of Hispanic students who participated in traditional instruction met grade level performance on PSAT 2018 with 6.1% of Hispanic students who participated in blended learning instruction. The results indicated 11.0% of Hispanic students were approaching grade level performance on PSAT 2018 who participated in traditional instruction with 7.3% of Hispanic students who participated in blended learning leaving 81.7% of Hispanic students who did not meet grade level performance in traditional instruction and 86.6% of Hispanic students who participated in blended instruction. Results indicated no Caucasian students met grade level expectations on PSAT 2018 and no Asian students met grade level expectations – regardless of instructional model. Of the Caucasian students in the matched sample, 33.3% of traditional instruction students were approaching grade level performance with 0.0% of blended instruction students. Of the 83.3% of Caucasian students who did not meet grade level performance, 66.7% of students participated in traditional instruction while 100% participated in blended learning instruction.

Results indicated 6.7% of African American students met grade level performance on PSAT 2018 participated in blended instruction with 0.0% of traditional instruction students. Of the African American students who were approaching grade level performance, 6.7% of students participated in blended instruction with 0.0% of students in traditional instruction. Of the African American students who did not meet grade level performance on PSAT 2018, 100% of students participated in traditional instruction while 86.6% participated in blended instruction.

Gender

When examining gender within the relationship between instructional model and post-secondary readiness in mathematics, Chi-square test of Independence and cross tabulations were conducted on gender with instructional model and PSAT 2018 grade level benchmark as the categorical variables (see Table 15). The results of the Chi-square test of independence indicated no statistically significant relationship between models of instruction and post-secondary readiness when measuring mathematics using PSAT 2018 and analyzing gender, Male, $\chi^2(2, N = 180) = 2.82, p = .244$; Female, $\chi^2(2, N = 192) = .359, p = .836$.

Table 15

Gender Cross Tabulation Results of PSAT 2018 Grade Level Benchmark by Instruction

Gender	Did not meet	Approaching	Meets
1. Male	152 (84.4%)	18 (10.0%)	10 (5.6%)
Traditional	72 (80.0%)	12 (13.3%)	6 (6.7%)
Blended	80 (88.9%)	6 (6.7%)	4 (4.4%)
2. Female	163 (84.9%)	15 (7.8%)	14 (7.3%)
Traditional	82 (85.4%)	8 (8.3%)	6 (6.3%)
Blended	81 (84.4%)	7 (7.3%)	8 (8.3%)

Note. Male, $\chi^2 = 2.82$, df = 2, p = .244; Female, $\chi^2 = .359$, df = 2, p = .836.

Of the males, 6.7% who participated in traditional learning met grade level expectations with 4.4% who participated in blended learning. Of the males approaching grade level expectation, 13.3% participated in traditional learning and 6.7% participated in blended learning. Of the males who did not meet grade level expectation, 84.4% participated in traditional learning while 88.9% participated in blended learning. The females in the sample outperformed the males with 6.3% of traditional instruction females meeting grade level expectation and 8.3% of blended learning females. Of the females who were approaching grade level performance, 8.3% participated in traditional instruction with 7.3% who participated in blended instruction. Of the 84.9% of females who did not meet grade level expectation, 85.4% participated in traditional learning and 84.4% participated in blended learning.

Special Education

When examining special education within the relationship between instructional model and post-secondary readiness in mathematics, Chi-square test of Independence and cross tabulation were conducted with instructional model and PSAT 2018 grade level benchmark as the categorical variables. The results of the Chi-square test of Independence indicated no statistically significant relationship with special education students within models of instruction and post-secondary readiness in mathematics, $\chi^2(1, N = 10) = 1.11, p = .292$. In other words, there is no relationship between one's participation in special education within models of instruction and post-secondary readiness in mathematics as shown in Table 16.

Table 16

Special Education Cross Tabulation Results of PSAT 2018 Grade Level Benchmark by Instruction

Special Education	Did not meet	Approaching	Meets
1. No	306 (84.5%)	32 (8.8%)	24 (6.6%)
Traditional	150 (82.9%)	19 (10.5%)	12 (6.6%)
Blended	156 (84.5%)	13 (7.2%)	12 (6.6%)
2. Yes	9 (90.0%)	1 (10.0%)	n/a
Traditional	4 (80.0%)	1 (20.0%)	n/a
Blended	5 (100%)	n/a	n/a

Note. $\chi^2 = 1.11$, df = 1, p = .292.

No students within the sample receiving special education services met grade level expectations on PSAT 2018. Of the students receiving special education services, 10.0% of students who participated in traditional learning were approaching grade level with 80.0% of traditional learning students not meeting grade level expectations. Of the blended learning students receiving special education, 100.0% did not meet grade level expectations.

English Learners

When examining English learners within the relationship between instructional model and post-secondary readiness in mathematics, Chi-square test of Independence and cross tabulation were conducted with instructional model and PSAT 2018 grade level benchmark as the categorical variables. The results of the Chi-square test of Independence indicate no statistically significant relationship on English learners within models of instruction and post-secondary readiness in mathematics, $\chi^2(1, N = 56) = 1.02$, $p = .313$. In other words, there is no relationship between student's English learner designation within instructional model and post-secondary readiness in mathematics when measured using PSAT 2018 as shown in Table 17. Of the English learners, 3.6% of students were approaching grade level expectation on PSAT 2018 who participated in blended learning with 0.0% of students who participated in traditional instruction. Of the English learners, 100.0% of students in traditional instruction did not meet grade level expectations while 96.4% of students in blended learning did not meet grade level expectations. Given the infancy of the blended learning model of instruction, the number of English learners in the sample was small. As implementation expands across the participating district and the number of English learners in the blended learning classroom grows, the results could be influenced more positively.

Table 17

English Learner Cross Tabulation Results of PSAT 2018 Grade Level Benchmark by Instruction

English learner	Did not meet	Approaching	Meets
1. No	260 (82.3%)	32 (10.1%)	24 (7.6%)
Traditional	126 (79.7%)	20 (12.7%)	12 (7.6%)
Blended	134 (84.8%)	12 (7.6%)	12 (7.6%)
2. Yes	55 (78.3%)	1 (15.2%)	n/a
Traditional	28 (100%)	n/a	n/a
Blended	27 (96.4%)	1 (3.6%)	n/a

Note. χ^2 = 1.02, df = 1, p = .313.

Economically Disadvantaged

When examining economically disadvantaged students within the relationship between instructional model and post-secondary readiness in mathematics, Chi-square test of Independence and cross tabulation were conducted with instructional model and PSAT 2018 grade level benchmark as the categorical variables. The results of the Chi-square test of Independence indicate no statistically significant relationship for economically disadvantaged students within models of instruction and post-secondary readiness in mathematics, χ^2(2, N = 330) = 1.43, p = .490. In other words, there is no relationship between models of instruction and post-secondary readiness in mathematics on economically disadvantaged students as shown in Table 18.

Table 18

Economically Disadvantaged Cross Tabulation Results of PSAT 2018 Grade Level Benchmark by Instruction

Economically Disadvantaged	Did not meet	Approaching	Meets
1. No	34 (81.0%)	3 (7.1%)	5 (11.9%)
Traditional	17 (81.0%)	2 (9.5%)	2 (9.5%)
Blended	17 (81.0%)	1 (4.8%)	3 (14.3%)
2. Yes	281 (85.2%)	30 (9.1%)	19 (5.8%)
Traditional	137 (83.0%)	18 (10.9%)	10 (6.1%)
Blended	144 (87.3%)	12 (7.3%)	9 (5.5%)

Note. $\chi^2 = 1.43$, df = 2, p = .490.

Of the students labeled as economically disadvantaged, 6.1% of traditional learning students met grade level expectations and 5.5% of blended learning students met grade level expectations. Of the traditional learning students labeled as economically disadvantaged, 10.9% were approaching grade level expectations with 83.0% of students who did not meet grade level expectations. Of the blended learning disadvantaged students not meeting grade level expectations, 7.3% were approaching grade level expectations with 87.3% not meeting grade level expectations. The results indicated students labeled as economically disadvantaged performed better on the PSAT 2018 when they participated in traditional instruction than in blended learning; but not enough to prove statistical significance.

Research Question Three

Research question three, *Is there a statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018*?, was answered using paired samples t-test with PSAT score as the repeated measure (dependent variable) and blended learning as the independent variable. The paired samples t-test was first conducted on the blended sample of all three participating sites and the results were shown in Table 19. The results of the paired samples t-test indicated that there is no statistically significant mean difference in post-secondary readiness when participating in blended learning between PSAT 2017 and PSAT 2018, $t(185) = 0.993$, $p = 0.322$. The mean scaled score for blended learning students in 2017 ($M = 383.66$) was slightly lower than the mean scale score for blended learning students in 2018 ($M=387.53$); but the mean difference was not statistically significant.

Table 19

Paired T-Test: PSAT Math Score 2017 and PSAT Math Score 2018

PSAT Math	N	M	SD	*t*-value	df	*p*-value
1. 2017	186	383.66	52.97	0.993	185	0.322
2. 2018	186	387.53	52.81			

*Statistically significant ($p < .05$)

To further investigate the question, each participating site was analyzed to determine if a statistically significant gain in post-secondary readiness existed when students participated in blended learning from PSAT 2017 and PSAT 2018 (see Table 20). The results of the paired samples t-test for Site A indicated that the results were consistent with district blended learning sample analysis with no statistically significant mean difference in post-secondary readiness when participating in blended learning, $t(41) = 0.425$, $p = 0.673$. The mean scale score for Site A blended learning students in 2017 ($M = 379.76$) was slightly lower than the mean scale score for Site A blended learning students in 2018 ($M = 383.57$); but the mean difference was not statistically significant.

Table 20

Paired T-Test: PSAT Math Score 2017 and PSAT Math Score 2018 by Site

PSAT Math	N	M	SD	*t*-value	df	*p*-value
1. Site A						
2017	42	379.76	57.78	0.425	41	0.673
2018	42	383.57	56.60			
2. Site B						
2017	75	397.87	45.78	0.528	74	0.599
2018	75	400.80	49.29			
3. Site C						
2017	69	370.57	54.18	0.730	68	0.468
2018	69	375.51	51.58			

*Statistically significant ($p < .05$)

The results of the paired samples t-test for Site B indicated the results were consistent with district blended learning sample analysis with no statistically significant mean difference in post-secondary readiness when participating in blended learning, $t(74) = 0.528$, $p = 0.599$. The mean scaled score for Site B blended learning students in 2017 ($M = 397.87$) was slightly lower than the mean scaled score for blended learning students in 2018 ($M = 400.80$); but the difference in mean scale score was not statistically significant. The results of the paired samples t-test for Site C indicated the results were consistent with district blended learning sample analysis with no statistically significant mean difference in post-secondary readiness when participating in blended learning, $t(68) = 0.730$, $p = 0.468$. The mean scaled score for Site C blended learning students in 2017 ($M = 370.57$) was slightly lower than the mean scale score for blended learning students in 2018 (M = 375.51); but the difference in mean scaled score was not statistically significant.

During blended learning classroom observations, the desk configurations and learning zones were not what you see in a typical traditional classroom. Students were empowered to make individual choices guided by their teachers to personalize their learning journey. The opportunities for learning were tailored to each individual student, which shifted control of learning from the teacher to the student. With more time for change to happen in the blended learning classroom as the implementation of the model matures in the participating district, the results on post-secondary readiness may begin to increase with more students demonstrating college readiness.

Research Question Four

Research question four, *Does participation in blended learning influence academic achievement in mathematics?*, was answered using independent samples t-test with model of instruction as the independent variable and the STAAR EOC math score as the dependent variable. The test was first conducted on the matched sample of all three participating sites and the results are shown in Table 21. The results of the independent samples t-test indicated that participation in blended learning did not influence academic achievement in mathematics, $t(370) = 0.533$, $p = 0.594$. The mean scale score for students participating in traditional instruction (M = 4001.18) was lower than the mean score for students participating in blended instruction (M = 4019.19); but the mean difference was not significant. Considering that equal variance was accounted for between the samples, it is possible that academic achievement is emerging as a result of blended learning instruction – the results are simply not there yet.

Table 21

Instructional Influence on Academic Achievement using STAAR EOC Scores

Instruction	N	M	SD	*t*-value	df	*p*-value
1. Traditional	186	4001.18	334.84	0.533	370	0.594
2. Blended	186	4019.19	316.48			

*Statistically significant ($p < .05$)

To further investigate the influence of blended learning on academic achievement in mathematics, an independent samples t-test was conducted on each participating site to determine if each site yielded the same results. The results of the independent samples t-test by site were shown in Table 22. The results of the independent samples t-test indicated that model of instruction at Site A did not influence academic achievement in mathematics, $t(82) = -1.861$, $p = 0.066$. The mean scale score for students participating in traditional instruction (M = 3961.76) was lower than the mean score for students participating in blended instruction (M = 4077.00) indicating students are beginning to outperform when participating in blended instruction. During classroom observations in the blended learning classroom, students engaged in learning either through: (a) direct instruction with the teacher, or (b) independently using technology, or (c) while completing a content assessment. The level of engagement was an indication that could explain the difference between traditional learning and blended learning mean scores at Site A.

The results of the independent samples t-test for Site B indicated that model of instruction did influence academic achievement in mathematics, $t(147.568) = -3.192$, $p = 0.002$, $d = 0.52$ (medium effect size), $r^2 = 0.636$. Students who participated in blended learning instruction (M = 4110.01) at Site B are, on average, scoring higher on STAAR

EOC than students who participated in traditional instruction (M = 3935.95) with approximately 63.6% of the variance attributed to model of instruction. During classroom observations at Site B, students exhibited evidence of learning through teacher facilitation. On one occasion, all students set goals as the warm-up activity before the learning cycle began. The teacher directed a small group of students needing intervention to a section of the room designated for small group instruction while others (depending on their individual goals) either went to the assessment zone or to the self-directed learning zone. As the class period progressed, the teacher monitored student progress to make certain all students were engaged in learning while still addressing the needs of the small group. The attention to personalize the learning for each individual student was evidenced through the teacher. The teacher was aware of each student and their learning journey and knew how to orchestrate the classroom to serve the needs of each individual student.

The results of the independent samples t-test for Site C indicated that model of instruction at Site C did influence academic achievement in mathematics, $t(136) = 3.980$, $p < 0.001$, $d = 0.678$ (medium effect size), and $r^2 = 0.103$. Students who participated in blended learning instruction (M = 3885.28) at Site C are, on average, scoring lower on STAAR EOC than students who participated in traditional instruction (M = 4096.09) with approximately 10.3% of the variance attributed to model of instruction. During classroom observation, the teacher exhibited great relationships with students; but did not attend to the learning goals of each individual student. Many students were off task with no apparent learning goal set for the class period. The teacher at Site C was a new teacher who was still working toward classroom management, which was evident in student performance and participation in the classroom.

Table 22

Instructional Influence on Academic Achievement using STAAR EOC Scores by Site

Instruction	N	M	SD	*t*-value	df	*p*-value
1. Site A						
Traditional	42	3961.76	269.14	-1.861	82	0.066
Blended	42	4077.00	297.71			
2. Site B						
Traditional	75	3935.95	342.82	-3.192	148	0.002*
Blended	75	4110.01	324.75			
3. Site C						
Traditional	69	4096.09	344.48	3.980	136	<.001*
Blended	69	3885.28	273.71			

*Statistically significant (p < .05)

Analyzing the campus sites individually for the influence of blended learning instruction on academic achievement yielded three different results with Site A data analysis revealing participation in blended learning did not influence academic achievement; but Site B analysis reveals that participation in blended learning did influence academic achievement with a higher mean score for students in blended learning. Data analysis for Site C also indicated participation in blended learning did influence academic achievement in mathematics; but the mean score was lower for students who participated in blended learning than for students who participated in traditional instruction.

Blended learning began as an instructional pilot beginning with implementation at only one high school campus. Site A was the pilot campus and has been implementing the blended model longer than Site B or Site C with Site C being the last to implement of the three participating campuses. The infancy of Site C's implementation of blended learning could be the factor influencing the mean scale score on this campus.

Research Question Five

Research question four, *Is there a relationship between blended learning participation and mathematics achievement?*, was answered using Chi-square test of Independence and cross tabulations with model of instruction and the STAAR EOC performance benchmark as the categorical variables. The data were analyzed by campus site, race/ethnicity, gender, participation in special education, English learner, and economically disadvantaged to gain insight into the relationship between blended learning and post-secondary readiness by campus site and by sub-population.

Campus Sites

The cross tabulation results were shown in Table 23 for all three participating high schools. The results of the Chi-squared test of Independence indicated no statistically significant relationship existed between model of instruction and mathematics achievement, $\chi^2(3, N = 372) = 1.12, p = .773$. In other words, students' mathematics achievement is not related to model of instruction; however, some differences do exist between traditional blended instruction. Of the students participating in traditional instruction, 17.7% mastered grade level performance with 19.4% of students participating in blended instruction. Of the students meeting grade level performance, 37.6% participated in traditional learning while 33.3% participated in blended learning. Of the students approaching grade level performance, 37.6% participated in traditional instruction and 41.4% participated in blended learning instruction. The number of students who participated in blended learning and did not meet grade level performance was less in the blended instruction. Of the students not meeting grade level performance, 7.0% participated in traditional learning while 5.9% participated in blended learning. Again, emerging evidence of promise existed when determining a relationship between blended learning and mathematics achievement as measured using STAAR Algebra I EOC across the three participating sites. The lack of statistical significance could be a result of the infancy of the blended learning implementation and could improve as implementation reaches maturation.

Table 23

Cross Tabulation Results of STAAR EOC Performance Benchmark and Instructional Model

Instructional Model	Did not meet	Approaching	Meets	Masters
1. Traditional	13 (7.0%)	70 (37.6%)	70 (37.6%)	33 (17.7%)
2. Blended	11 (5.9%)	77 (41.4%)	62 (33.3%)	36 (19.4%)

Note. $\chi^2 = 1.12$, df = 3, p = .773.

Investigating the question further by looking at each participating site independently, Chi-square test of Independence and cross tabulations were conducted on each of the three sites individually. The results of the Chi-square test of Independence for Site A indicated that no statistically significant relationship existed between model of instruction and mathematics achievement when measured using STAAR Algebra I EOC, $\chi^2(3, N = 84) = 4.72$, p = .194 (see Table 24). The number of students who mastered grade level performance was higher in the blended classroom than the traditional classroom. Of the students at Site A who mastered grade level performance, 7.1% participated in traditional learning while 21.4% participated in blended learning. Of the students at Site A who met grade level performance on STAAR Algebra I EOC, 42.9%

participated in traditional learning while 45.2% participated in blended learning. Of the students who were approaching grade level performance, 42.9% participated in traditional learning while 26.2% participated in blended learning. Of the six students who did not meet grade level performance, 7.1% participated in traditional learning and 7.1% participated in blended learning.

The results for Site B yielded a different result indicating a statistically significant relationship existed between model of instruction and mathematics achievement, $\chi^2(3, N = 150) = 8.95, p = .030$ (see Table 23). Of the students at Site B who mastered grade level performance, 14.7% participated in traditional learning while 28.0% participated in blended learning. Of the students who met grade level performance, 29.3% participated in traditional learning while 38.7% participated in blended learning. Of the students who were approaching grade level performance, 48.0% participated in traditional learning while 30.7% participated in blended learning. Of the students who did not meet grade level performance, 8.0% participated in traditional learning while 2.7% participated in blended learning. Results indicated that students participating in blended learning at Site B are increasing mathematics academic achievement when measured using STAAR Algebra I EOC. According to NCES (2015a), student performance in mathematics at the high school level has not significantly differed in the past several decades. A finding that indicated a statistical significance warrants further exploration to replicate the results at other sites.

The results for Site C are similar to Site B that indicated a statistically significant relationship existed between model of instruction and mathematics achievement, χ^2 (3, N = 138) = 25.33, $p < .001$ (see Table 23). However, the similarity ended at significance with students in traditional learning who outperformed students in blended learning. Of the students at Site C who mastered grade level performance, 27.5% participated in traditional learning while 8.7% participated in blended learning. Of the students who met grade level performance, 43.5% participated in traditional learning while 20.3% participated in blended learning. Students approaching and not meeting grade level performance outnumbered the traditional learning students. Of the students at Site C approaching grade level performance, 23.2% participated in traditional learning while 62.3% participated in blended learning. Of the students not meeting grade level performance, 5.8% participated in traditional learning while 8.7% participated in blended learning. Students who participated in blended learning at Site C were not making the same gains as students at the other high school sites. At the time students participated in STAAR Algebra I EOC, the blended teacher at Site C was a first-year teacher in a new instructional model which could explain some of the variance in performance between Site C and the other campuses.

The results did not remain consistent when measured as independent campuses indicating that the campus students attend determined if a relationship existed between blended learning participation and mathematics achievement. Instructors with differing levels of experience in mathematics as well as blended learning classroom experience described the teacher sample and could explain why mathematics achievement results are different by site. It is possible, given time, that as the teachers grow in their level of expertise and the process of change continues to evolve within the classroom, performance will begin to be impacted consistently across campuses within the participating district.

Table 24

Cross Tabulation Results of STAAR EOC Performance Benchmark and Instruction by Participating Site

Instructional Model	Did not meet	Approaching	Meets	Masters
1. Site A				
Traditional	3 (7.1%)	18 (42.9%)	18 (42.9%)	3 (7.1%)
Blended	3 (7.1%)	11 (26.2%)	19 (45.2%)	9 (21.4%)
2. Site B				
Traditional	6 (8.0%)	36 (48.0%)	22 (29.3%)	11 (14.7%)
Blended	2 (2.7%)	23 (30.7%)	29 (38.7%)	21 (28.0%)
3. Site C				
Traditional	4 (5.8%)	16 (23.2%)	30 (43.5%)	19 (27.5%)
Blended	6 (8.7%)	43 (62.3%)	14 (20.3%)	6 (8.7%)

Note. Site A: $\chi^2 = 4.72$, df = 3, p = .194; Site B: $\chi^2 = 8.95$, df = 3, p = .030; Site C: $\chi^2 = 25.33$, df = 3, p < .001.

Race/Ethnicity

When examining race/ethnicity within the relationship between model of instruction and mathematics achievement, Chi-square test of Independence and cross tabulation were conducted with models of instruction and STAAR EOC performance benchmarks as the categorical variables. The results of the Chi-square test of Independence indicated no statistically significant relationship of race/ethnicity between instructional model and mathematics achievement, Caucasian, $\chi^2(2, N = 6) = 1.3$, p =.513; African American, $\chi^2(3, N = 30) = 3.44$, p = .328; Hispanic, $\chi^2(3, N = 328) = 2.78$, p =.427; Asian, $\chi^2(1, N = 2) = 2.0$, p = .157; Other, $\chi^2(3, N = 6) = 3.33$, p = .343. In other words, mathematics achievement was not related to model of instruction for students of different ethnicities (see Table 25).

Table 25

Race/Ethnicity Cross Tabulation Results of STAAR EOC Performance Benchmark by Instruction

Race/Ethnicity	Did not meet	Approaching	Meets	Masters
1. Caucasian	n/a	1 (16.7%)	2 (33.0%)	3 (50.0%)
Traditional	n/a	1 (33.3%)	1 (33.3%)	1 (33.3%)
Blended	n/a	n/a	1 (33.3%)	2 (66.7%)
2. African American	3 (10.0%)	16 (53.3%)	9 (30.0%)	2 (6.7%)
Traditional	1 (6.7%)	10 (66.7%)	4 (26.7%)	n/a
Blended	2 (13.3%)	6 (40.0%)	5 (33.3%)	2 (13.3%)
3. Hispanic	20 (6.1%)	128 (39.0%)	117 (35.7%)	63 (19.2%)
Traditional	11 (6.7%)	57 (34.8%)	64 (39.0%)	32 (19.5%)
Blended	9 (5.5%)	71 (43.3%)	53 (32.3%)	31 (18.9%)
4. Asian	n/a	1 (50.0%)	1 (50.0%)	n/a
Traditional	n/a	1 (100.0%)	n/a	n/a
Blended	n/a	n/a	1 (100%)	n/a
5. Other	1 (16.7%)	1 (16.7%)	3 (50.0%)	1 (16.7%)
Traditional	1 (33.3%)	1 (33.3%)	1 (33.3%)	n/a
Blended	n/a	n/a	2 (66.7%)	1 (33.3%)

Note. Caucasian, $\chi^2 = 1.3$, df = 2, p = .513; African American, $\chi^2 = 3.4$, df = 3, p = .328; Hispanic, $\chi^2 = 2.8$, df = 3, p = .427; Asian, $\chi^2 = 2.0$, df = 1, p = .157; Other, $\chi^2 = 3.3$, df = 3, p = .343.

The race/ethnicity with the largest sample population was Hispanic. Of the Hispanic students who mastered grade level expectation, 19.5% participated in traditional learning while 18.9% participated in blended instruction. Of the Hispanic students who met grade level performance, 39.0% participated in traditional learning and 32.3%

participated in blended learning. Results indicated more Hispanic students were approaching grade level performance and did not meet grade level performance who participated in blended learning than those who participated in traditional learning. Of the Hispanic students who approached grade level performance, 34.8% participated in traditional learning while 43.4% participated in blended learning. Of the Hispanic students who did not meet grade level performance, 6.7% participated in traditional learning while 5.5% participated in blended learning.

Gender

When examining gender within the relationship between instructional model and mathematics achievement, Chi-square test of Independence and cross tabulation were conducted on gender with instructional model and STAAR EOC performance benchmark as the categorical variables. The results of the Chi-square test of Independence indicated no statistically significant relationship existed between model of instruction and mathematics achievement measured using STAAR Algebra I EOC for students of different genders, Male, $\chi^2(3, N = 180) = 3.04, p = .385$; Female, $\chi^2(3, N = 192) = .667, p = .881$. In other words, there is no relationship between one's gender within instructional model and mathematics achievement as shown in Table 26; however, some cross tabulation results are worth noting. More males demonstrated performance at the meets grade level performance and masters grade level performance of STAAR Algebra I EOC if they participated in traditional instruction; whereas female students performed slightly higher if they participated in blended learning. More female students (37.5%) outperformed male students (33.3%) at the meets grade level performance on STAAR EOC when viewing combined results.

Of the male students who mastered grade level performance, 18.9% participated in traditional learning and 17.8% participated in blended learning. Of the male students who met grade level performance, 37.8% participated in traditional learning while 28.9% participated in blended learning. Of the female students who mastered grade level performance, 16.7% participated in traditional learning and 20.8% participated in blended learning. Of the female students who met grade level performance, 37.5% participated in traditional learning while 27.5% participated in blended learning.

Table 26

Gender Cross Tabulation Results of STAAR EOC Performance Benchmark by Instruction

Gender	Did not meet	Approaching	Meets	Masters
1. Male	12 (6.7%)	75 (41.7%)	60 (33.3%)	33 (18.3%)
Traditional	7 (7.8%)	32 (35.6%)	34 (37.8%)	17 (18.9%)
Blended	5 (5.6%)	43 (47.8%)	26 (28.9%)	16 (17.8%)
2. Female	12 (6.3%)	72 (37.5%)	72 (37.5%)	36 (18.8%)
Traditional	6 (6.3%)	38 (39.6%)	36 (37.5%)	16 (16.7%)
Blended	6 (6.3%)	34 (35.4%)	36 (37.5%)	20 (20.8%)

Note. Male, χ^2 = 3.04, df = 3, p = .385; Female, χ^2 = 0.67, df = 3, p = .881.

Special Education

When examining special education within the relationship between models of instruction and mathematics achievement, Chi-square test of Independence and cross tabulation were conducted with instructional model and STAAR EOC performance benchmark as the categorical variables. The results of the Chi-square test of independence indicate no statistically significant relationship existed between special education and mathematics achievement when measured using STAAR Algebra I EOC, $\chi^2(2, N = 10) = 4.29$, p = .117. In other words, the results indicated no relationship between instructional model and mathematics achievement for students receiving special education services (see Table 27). The number of special education students within the sample is cause for concern. To be a part of the sample, a student had to be enrolled in blended learning instruction and then individually matched to a student receiving traditional instruction. The number of students in the blended learning sample receiving special education services was insignificant, indicating the results do not offer any significant analysis on mathematics achievement.

Table 27

Special Education Cross Tabulation Results of STAAR EOC Performance Benchmark by Instruction

Special Education	Did not meet	Approaching	Meets	Masters
1. No	23 (6.4%)	140 (38.7%)	130(35.9%)	69 (19.1%)
Traditional	13 (7.2%)	65 (35.9%)	70 (38.7%)	33 (18.2%)
Blended	10 (5.5%)	75 (41.4%)	60 (33.1%)	36 (19.9%)
2. Yes	1 (10.0%)	7 (70.0%)	2 (20.0%)	n/a
Traditional	n/a	5 (100.0%)	n/a	n/a
Blended	1 (20.0%)	2 (40.0%)	2 (40.0%)	n/a

Note. χ^2 = 4.29, df = 2, p = .117.

English Learners

When examining English learners within the relationship between instructional model and mathematics achievement, Chi-square test of Independence and cross tabulation were conducted with instructional model and STAAR Algebra I EOC performance benchmarks as the categorical variables. The results of the Chi-square test of Independence indicated no statistically significant relationship existed for English learners within instructional model and mathematics achievement, $\chi^2(3, N = 56) = 3.69$, p = .297. In other words, there is no relationship between one's English learner designation within instructional model and achievement in mathematics (see Table 28).

Table 28

English learner Cross Tabulation Results of STAAR EOC Performance Benchmark by Instruction

English learner	Did not meet	Approaching	Meets	Masters
1. No	16 (5.1%)	117 (37.0%)	119 (37.7%)	64 (20.3%)
Traditional	9 (5.7%)	58 (36.7%)	62 (39.2%)	29 (18.4%)
Blended	7 (4.4%)	59 (37.3%)	57 (36.1%)	35 (22.2%)
2. Yes	8 (14.3%)	30 (53.6%)	13 (23.2%)	5 (8.9%)
Traditional	4 (14.3%)	12 (42.9%)	8 (28.6%)	4 (14.3%)
Blended	4 (14.3%)	18 (64.3%)	5 (17.9%)	1 (3.6%)

Note. χ^2 = 3.69, df = 3, p = .297.

The cross tabulation results indicated a gap in achievement between English learner students and English native students. Of the English learner students mastering grade level performance on STAAR Algebra I EOC, 14.3% participated in traditional learning while 3.6% participated in blended learning. Comparing to native English students, 18.4% of students participated in traditional learning while 22.2% of students participated in blended learning. Of the English learner students meeting grade level performance, 28.6% participated in traditional learning and 17.9% participated in blended learning. Comparing to native English students, 39.2% participated in traditional learning while 36.1% participated in blended learning.

Economically Disadvantaged

When examining economically disadvantaged students within the relationship between instructional model and mathematics achievement, Chi-square test of Independence and cross tabulation were conducted with instructional model and STAAR EOC performance benchmark as the categorical variables. The results of the Chi-square test of Independence indicated no statistically significant relationship for disadvantaged students within instructional model and mathematics achievement, $\chi^2(3, N = 330) = 1.64$, $p = .651$. In other words, there is no relationship between instructional model and achievement in mathematics when examining economically disadvantaged students as shown in Table 29. The cross tabulations indicated an achievement gap between students participating in blended learning or traditional learning who are economically disadvantaged and those who are not disadvantaged.

Table 29

Economically Disadvantaged Cross Tabulation Results of STAAR EOC Performance Benchmark by Instruction

Economically Disadvantaged	Did not meet	Approaching	Meets	Masters
1. No	2 (4.8%)	13 (31.0%)	15 (35.7%)	12 (28.6%)
Traditional	1 (4.8%)	8 (38.1%)	7 (33.3%)	5 (23.8%)
Blended	1 (4.8%)	5 (23.8%)	8 (38.1%)	7 (33.3%)
2. Yes	22 (6.7%)	134 (40.6%)	117 (35.5%)	57 (17.3%)
Traditional	12 (7.3%)	62 (37.6%)	63 (38.2%)	28 (17.0%)
Blended	10 (6.1%)	72 (43.6%)	54 (32.7%)	29 (17.6%)

Note. $\chi^2 = 1.64$, df = 3, p = .651.

Of the economically disadvantaged students who mastered grade level performance on STAAR Algebra I EOC, 17.0% participated in traditional learning while 17.6% participated in blended learning. Of the students who are not economically disadvantaged, 23.8% participated in traditional learning while 33.3% participated in blended learning. Of the economically disadvantaged students who met grade level performance, 38.2% participated in traditional learning and 32.7% participated in blended learning. Comparing to the students who are not economically disadvantaged who met grade level performance, 33.3% participated in traditional learning while 38.1% participated in blended learning.

Research Question Six

Research question six, *What are the observable and teacher perceived characteristics of the blended learning classroom?*, was answered qualitatively through data collected from classroom observations, teacher interviews, and classroom artifacts such as bell schedules and classroom diagrams collected from each participating campus. The environment of the blended learning classroom, the student engagement, and the role of the teacher are vastly different than that of traditional learning. According to Frontier and Rickabaugh (2014), education needs to "move away from the assembly-line, batch-processing approach and focus more on how best to meet the needs and tap the interests and talents of individual learners" (p. 163). To expect a different academic result, a process of change to personalize the learning needs of the individual student is being implemented in the participating district. A day in the life of a blended learning student in the participating district is vastly different from the batched approach to learning described above.

During blended learning classroom observations, students were observed owning their learning and dictating their own path toward mastery of content. Student ownership of learning was evident in the tasks students independently engaged in while working on their own or in small groups. The teacher in the blended learning classroom was not observed directing the learning or dominating classroom discourse. The opposite was true during the classroom observations where students dominated the classroom talk shifting the focus in the blended learning classroom to the student and away from the teacher. One description would not suffice to represent the blended learning classroom as all classrooms functioned differently depending on the structure observed. An analysis of the blended learning classroom explained how the process of change in the participating district emerged to be a model that personalizes learning for individual students, allowing the student to develop agency in the classroom and to become self-directed in their learning. To develop an understanding of what the blended learning classroom was like in the participating district, an examination of the key characteristics found in the blended learning classroom were discussed and included blended learning classroom structures, scheduling, and learning flexibility found within the blended learning model of instruction during observations.

Blended Learning Classroom Structures

During classroom observations, three blended learning structures were observed to gain insight into how each structure was implemented and to observe what the teacher was doing and what the students were doing during each of the classroom structures. The three classroom structures are defined as: (a) 1:1 mentoring, (b) concept unit time, and (c) self-directed learning (SDL). When observations were during 1:1 mentoring, teachers were observed communicating with one student at the teacher desk while all other students were engaged in independent learning – tasks chosen by each student to support their individual learning goals. When observations were during concept unit time, the teacher facilitated group discussions (sometimes-whole group and sometimes-small group) as students formulated knowledge and discovered mathematical relationships. When observations were conducted during SDL, students were working on procedural fluency in the blended learning platform using technology. The paths for developing procedural fluency were orchestrated by the individual student with some students notetaking while other students watched videos before practice and attempting the content assessment. The only way to know what the student objectives were for the day during SDL observations were to ask the individual students themselves. To better understand each of the three classroom structures, an in-depth look into each of the observed structures follows.

Each classroom structure was scheduled for observation twice during the fall semester; however, data were collected on what was happening in the classroom during the observation. The classroom observations conducted by campus site are shown in Table 30. It is important to note that classroom observations were scheduled equally across campus sites and structures; but high schools are large entities with many factors that pull on the published schedule, e.g. sporting events, assemblies, and common assessments. Teachers were given the flexibility by campus administration to adjust their schedules to meet the needs of their students; therefore, the structure reflected in the schedule was not always the reality in the classroom and is reflected in the number of observations by structure (see Table 30). If a substitute was present in the classroom, then a classroom observation was not recorded. In some instances, multiple attempts to observe a specific structure resulted in additional observations of another structure.

Table 30

Blended Learning Geometry Classroom Observations by Site

Blended Classroom	1:1 Mentoring	Concept Unit Time (CT)	Self-Directed Learning (SDL)
1. Site A	2	2	4
2. Site B	1	1	2
3. Site C	1	2	1

Note: Actual observation was coded using structure present in classroom, not according to schedule.

The blended learning model of instruction implemented in the participating district has explicitly defined structures to be evidenced in practice regularly. The structures are defined by Summit Learning (2018) as follows: (a) 1:1 mentor check-ins, (b) math concept units, and (3) self-directed learning. Each structure was observed during classroom observations and discussed during interviews.

1:1 Mentor Check-in. Specific criteria must be met during 1:1 mentor check-ins for the structure to be implemented with fidelity. The key criteria for full implementation of the model are as follows: (a) order and timing based on student data, (b) coaching on habits based on student data, (c) positive relationships between teacher and students, (d) showing compassion to soothe stress, (e) opportunities for students to self-assess, (f) developing skills for student to facilitate the check-in, (g) accountability for setting and achieving learning goals, (h) setting clear actionable next steps, and (i) set up for success. Evidence of the 1:1 mentor check-in key criterion during classroom observations are shown in Table 31.

Table 31

1:1 Mentor Check-in Key Criterion during Classroom Observations

Key Criteria	Evidence	Missed Opportunity	Not Observed
1. Order and Timing	2 (50.0%)	1 (25.0%)	1 (25.0%)
2. Coaching on Habits	4 (100.0%)	n/a	n/a
3. Positive Relationships	4 (100.0%)	n/a	n/a
4. Soothing Stress	1 (25.0%)	n/a	3 (75.0%)
5. Self-Assessment	4 (100.0%)	n/a	n/a
6. Student Facilitation	2 (50.0%)	2 (50.0%)	n/a
7. Setting Learning Goals	2 (50.0%)	2 (50.0%)	n/a
8. Next Steps	2 (50.0%)	1 (25.0%)	1 (25.0%)
9. Set up for Success	3 (75.0%)	1 (25.0%)	n/a

Note: See Appendix C for Classroom Observation Tool.

To record evidence of the key criteria, the researcher used the following actions. *Order and timing* were evident when the teacher had a posted schedule of the student mentoring order that was based on the need of the student. Student need was based on recorded evidence in the student grades in the course. *Coaching on habits* was evident when the teacher or student explicitly referenced at least one of the habits of success. *Positive relationships* were evident when the teacher (mentor) and student engaged in discourse easily without the teaching eliciting information from the student. *Soothing stress* was evident when the teacher responded to a student comment indicating the student was stressed about school or home. *Self-assessment* was evident when the student articulated the understanding of where they were in their own personal learning journey and was able to identify a need (or an accomplishment). *Student facilitation* was evident when the student took the lead in the conversation instead of just responding to the teacher's lead. *Setting learning goals* was evident when the student had clear action steps that were articulated during the 1:1 mentor check-in. *Next steps* was evident when the student walked away with clear goals and action steps recorded for the week. *Set up for success* was evident when the student left the 1:1 mentor check-in with the resources to meet their goals.

During observations of mentor check-ins teachers consistently coached students on habits of success (100.0%), built positive relationships (100.0%), and provided opportunities for students to self-assess (100.0%). During observations, teachers demonstrated positive relationships with students through the ease of conversation with each student. It appeared evident that this was routine for students based on the level of conversation and willingness to engage in meaningful dialogue with the teacher. One teacher who was actively mentoring a student during observation said to a student, "You set 14 goals this week and completed all 14 goals! What are you doing to achieve your goals?" This was a key move by the teacher (mentor) to allow the student to self-assess and reflect on how she reached her goals. The student responded candidly with how the goals were achieved through study and assessment providing the student opportunity to reflect on her habits of success. During another observation a student was struggling with habits of success by not completing work in a timely fashion, so the teacher responded by providing some resources to help the student work through procrastination. A resource referenced by the teacher was using a calendar to create a personal timeline that chunked learning into manageable parts that would help the student through procrastination. According to NCTM (2014), teachers "develop socially, emotionally, and academically safe environments for mathematics teaching and learning – environments in which students feel safe to engage with one another and with teachers" (p. 115). The actions of both teachers and students during 1:1 mentor check-ins seems to support this NCTM access and equity principle ensuring mathematics achievement for all students.

Key criteria where missed opportunities were the greatest were student facilitation (50.0%) and setting learning goals (50.0%). During observations, it was clear teachers were dependent on the mentoring script when meeting with students and were allowing the script to dictate the conversation instead of allowing the student to facilitate. The over-reliance on the 1:1 mentoring script appeared to rob the student of the opportunity to lead the discussion. As the reliance on the mentoring script decreases, the opportunities for students to facilitate the conversation would likely increase. Even though setting learning goals was key criteria that was missed, it was evident during 1:1 mentoring observations that teachers were mentoring on individual student progress. Teachers asked questions such as: (a) What happened last week that you are most proud of academically?, (b) What did you do to meet your goals?, (c) Did you encounter any obstacles? If so, what were they?, (d) How will this experience help you in the future?, and (e) What goals are you setting for next week?.

During one specific 1:1 mentoring observation, it was evident the teacher had a great rapport with the student. During the observation, the teacher (mentor) and student engaged in casual conversation about the student's weekend with the student sharing experiences with ease. However, at the end of the 1:1 mentor check-in the student had not defined learning goals (as an action step birthed from the conversation). Without the critical criteria of student academic goal setting, the 1:1 mentor check-in becomes a conversation without a defined academic purpose emerging more as an informal chat with no apparent academic outcome. The magnitude of change increases during 1:1

mentor check-ins when the teacher helps the student develop purpose and action to achieve mastery of the learning outcomes (Frontier & Rickbaugh, 2014).

Math Concept Unit. Specific criteria must be met during math concept units to be implemented with fidelity. The key criteria for full implementation of the model are as follows: (a) the teacher facilitates a compelling launch to the unit, (b) the teacher facilitates a clean launch to the unit, (c) the teacher develops the question by asking students what they notice and what they wonder, (d) the teacher primes student's thinking, (e) the students engage in rigorous discourse, (f) the teacher highlights the lesson's enduring understandings during the wrap, (g) the teacher selects and sequences student contributions when building the lesson's enduring understanding, (h) the teacher makes explicit connections to extend student thinking, (i) the teacher promotes mathematical coherence, and (j) the teacher solicits student thinking. Evidence of the concept unit key criteria during classroom observations are shown in Table 32.

To record evidence of the key criteria, the researcher used the following actions. A *compelling launch* was evident when the teacher posed an interesting real-world connection to the content that primed student's thinking. *Developing the question* was evident when the teacher asked the students what they noticed or what they wondered after displaying the artifact during the compelling launch. *Prime students' thinking* was evident when the teacher asked rigorous questions that caused students to respond with an explanation or justification. *Rigorous discourse* was evident when the teacher continued to engage students in extending their thinking during learning. *Enduring understandings* was evident when the teacher highlighted the lesson objective during the lesson or at the end of the lesson within the unit. *Selecting and sequencing* was evident when student contributions to the lesson built the lesson toward conceptual development (not procedural fluency). *Connections* was evident when the teacher asked students to extend their thinking by asking extension questions such as "What if…". *Mathematical coherence* was evident when the teacher connected the learning to past learning and future learning. *Solicits student's thinking* was evident when the teacher went beyond the answer by asking questions such as, "why" or "how do you know".

Table 32

Math Concept Unit Key Criteria during Classroom Observations

Key Criteria	Evidence	Missed Opportunity	Not Observed
1. Compelling Launch	2 (40.0%)	2 (40.0%)	1 (20.0%)
2. Clean Launch	3 (60.0%)	2 (40.0%)	n/a
3. Develop the Question	2 (40.0%)	3 (60.0%)	n/a
4. Prime Students' Thinking	2 (40.0%)	3 (60.0%)	n/a
5. Rigorous Discourse	2 (40.0%)	3 (60.0%)	n/a
6. Enduring Understandings	n/a	n/a	5 (100.0%)
7. Selecting and Sequencing	1 (20.0%)	1 (20.0%)	3 (60.0%)
8. Connections	3 (60.0%)	1 (20.0%)	1 (20.0%)
9. Mathematical Coherence	4 (80.0%)	n/a	1 (20.0%)
10. Solicit Student Thinking	3 (60.0%)	1 (20.0%)	1 (20.0%)

Note: See Appendix C for Classroom Observation Tool.

Observing all key criteria for math concept units was a difficult task because of the nature of the lesson cycle within the units. For instance, a compelling launch for a lesson within the concept unit may have occurred the day before the observation or prior to our arrival. This is also true about teachers developing the question – which is closely related to the launch of the unit by asking students what they notice or what they wonder about the prompt (provided during the launch of the lesson). When a compelling launch was observed the teacher was acting as the facilitator of learning unlike the traditional classroom where the teacher primarily delivers information without student construction of knowledge. During one classroom observation, the teacher presented the students with an image and asked the students what they noticed and wondered about the image. The teacher then elicited responses from students to develop the question connecting the image to the day's conceptual learning. During the launch of the lesson, the teacher acted as the facilitator of knowledge rather than the giver of knowledge. The students in the classroom were given the opportunity to discover connections and explain their mathematics before engaging in any procedural practice. The use of a rich problem constructed to elicit student thinking was the driving force during the observation. "Effective [mathematics] teaching not only acknowledges the importance of both conceptual understanding and procedural fluency but also ensures that the learning of procedures is developed…on a strong foundation of understanding and the use of student-generated strategies in solving problems" (NCTM, 2014, p. 46).

One key similarity to the traditional classroom is that typically when developing conceptual understanding, the blended teacher is pacing the class through an activity before releasing the learning to the students (which could mirror batch-process – a term used previously to describe traditional instruction); however, the blended teacher is still acting as a facilitator. As an example of this type of student pacing, a teacher paced students through an investigation of a mathematical concept using a virtual application while students were talking and drawing conclusions based on data presented. As students shared out their conclusions, students engaged in academic debate surrounding the conclusions in whole group discussion. The teacher listened to the dialogue and facilitated the discussion by asking questions when necessary to drive the discourse toward a specific mathematical concept. The virtual application was open on all student devices with the teacher displaying student work using an anonymizer to hide student identity. One teacher commented on this type of instruction saying, “What I really like about blended learning is when I can guide them, they can learn a lot more compared to what they would if I was standing in front teaching them”. Another teacher commented on facilitating learning during a concept unit by saying:

> I remember one concept unit where I provided students with the directions, explained what tools they could use and then they went on and completed the work. That was weird for me because I felt like I wasn’t actually teaching. I was literally just walking around making sure students were on task and answering questions with a question when they arose.

The blended learning classroom appeared to require a level of vulnerability on the part of the teacher as the teachers shifted their mindset toward a more progressive approach to learning and acting as the facilitator of learning and not the teacher. Mathematics teachers traditionally orchestrate the learning in the classroom being in complete control; however, in the blended learning classroom the control seemed to shift to the student increasing the cognitive lift for the student while decreasing the role of the teacher – leaving the teacher vulnerable as the lesson played out in the classroom to respond to the needs of the students instead of dictating every step of the lesson.

Of the math concept unit key criteria observed most often in the classroom, mathematical coherence (80.0%) was marked as evidenced with developing the question (60.0%), prime students’ thinking (60.0%) and rigorous discourse (60.0%) marked as missing from the classroom. Teachers consistently promoted students’ development of a coherent view of mathematics by supporting meaning connections between procedural fluency and conceptual understanding; but were missing the opportunity to extend student thinking by explicitly connecting student contributions to enrich understanding. To illustrate this point, during an observation a teacher was leading students through the discovery on congruence relationships building off prior knowledge. The discussion fell short of comparing understanding between students to enrich understanding- the teacher stopped once a single response satisfied the teacher's expectation. During this same observation, the connection between conceptual development and procedural fluency was evident as the teacher used multiple representations to further the investigation such as: (a) figures on the coordinate plane, (b) constructing congruent figures, and (c) connecting the proof of congruence to words, symbols, and algebraic representations.

Observations were consistent with many of the criteria; but it is interesting to note that not one teacher commented during the interviews about concept unit time. Concept unit time is devoted to developing the conceptual understanding of the mathematics. Teachers were eager to talk about self-directed learning and the ability to differentiate but did not share insight into concept unit time specifically. The similarity to the traditional classroom is that this component has an element of whole group instruction could be the reason the teachers did not provide commentary on this structure of the blended classroom. It warrants mentioning, though, that "effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments" (NCTM, 2014, p. 10) is a necessary mathematics practice to implement as students develop conceptual understanding.

Self-Directed Learning (SDL). Specific criteria must be met during self-directed learning time to be implemented with fidelity. The key criteria for full implementation of self-directed learning are as follows: (a) students have an articulated goal related to academic outcomes, (b) students have an articulated plan based on available data, (c) students can articulate content assessment readiness, (d) teacher maintains content assessment security, (e) students can reflect on their learning, (f) students work with urgency to maximize learning time, (g) students have structured ways to get on-demand help, (h) students have authentic peer support, (i) teacher facilitates partial group interventions, and (j) students have one-to-one check-ins when needed. Evidence of self-directed learning key criteria during classroom observations are shown in Table 33. Some of the key criteria observed the most during classroom observations were articulated goal (100.0%), articulated plan (85.7%), and reflection (85.7%). Content assessment readiness (57.1%), content security (57.1%), maximizing learning (57.1%) and peer support (57.1%) were observed during some classroom observations. Some of the areas not consistently observed partial group interventions (14.3%), on demand help (42.9%) and one-to-one check-ins (42.9%).

To record evidence of the key criteria, the researcher used the following actions. *Articulated goal* was evident when students demonstrated they had actionable goals to be completed by the end of the period. *Articulated plan* was evident when the teacher knew exactly what each student needed to complete by the end of the period. *Content Assessment Readiness* was evident when students could explain how they knew they were ready to take a content assessment. *Content assessment security* was evident when the teacher had a dedicated space where students worked on assessments independently. *Reflection* was evident when students could articulate what they were working on in relation to their performance. *Maximizing learning* was evident when students were engaged in learning and all students were on task. *On-demand help* was evident when students had access to the teacher or a peer for support when needed. *Peer support* was evident when students had access to a peer for academic support during class. *Partial* *group intervention* was evident when the teacher worked with a small group during the observation. When the teacher was available for students to ask questions on demand, then *1:1 check-ins* were evident.

Table 33

Self-Directed Learning Key Criteria during Classroom Observations

Key Criteria	Evidence	Missed Opportunity	Not Observed
1. Articulated Goal	7 (100.0%)	n/a	n/a
2. Articulated Plan	6 (85.7%)	1 (14.3%)	n/a
3. Content Assessment Readiness	4 (57.1%)	1 (14.3%)	2 (28.6%)
4. Content Assessment Security	4 (57.1%)	1 (14.3%)	2 (28.6%)
5. Reflection	6 (85.7%)	1 (14.3%)	n/a
6. Maximizing Learning	4 (57.1%)	3 (42.9%)	n/a
7. On-Demand Help	3 (42.9%)	2 (28.6%)	2 (28.6%)
8. Peer Support	4 (57.1%)	1 (14.3%)	2 (28.6%)
9. Partial Group Intervention	1 (14.3%)	1 (14.3%)	5 (71.4%)
10. 1:1 Check-Ins	3 (42.9%)	1 (14.3%)	3 (42.9%)

Note: See Appendix C for Classroom Observation Tool.

The dynamics of the classroom during self-directed learning is richly differentiated and provided evidence of personalized learning in the blended learning classroom. As an observer in the classroom, the teacher becomes the conductor of an orchestra of mathematical learning with many moving pieces. Students were not in lock-step with the teacher; but fluidly engaging in learning wherever they were on that journey. Students were observed moving from a learning zone to an assessment zone when they were ready. Teachers determined assessment readiness when students could produce evidence of learning such as note taking over content and completion of practice problems to develop procedural fluency. Some students were observed in small group intervention while others worked on their own personalized learning plan. During one classroom observation, it was noted that 17 students were on task with one student off task – a high student engagement ratio. During an observation, a student commented to the observer that being in the blended learning classroom was helping her to become more self-directed and preparing her to be successful in college providing evidence to the development of habits of success. During observation, one student encouraged another student as she assured him he had worked hard and studied to perform well on the content assessment providing additional evidence of the development of habits of success. Students appeared to develop agency in the mathematics classroom as they supported one another with no apparent instruction to do so.

In the blended learning classroom, students chose the resources that suited them best from a playlist of resources within each procedural fluency focus area. During observations, it appeared when students felt they had mastered the content, they let the teacher know they were ready to assess their learning and the teacher then opened the assessment for the individual student. The student moved to the assessment zone and completed the assessment independently. To reach mastery on a content assessment, the student must score an eight out of ten before moving on to the next objective or focus area. It seems teachers cannot enter a completion grade or remove a grade for a student in the blended learning platform inferring students had to earn the grade. If an eight is not achieved, then the student went back to the resources and studied some more to attempt the assessment a second time. One teacher commented on the achievement of a student saying:

> One of my greatest joys working in blended learning is the self-pacing and personalization. A student nearly perfected the content assessment being only one away and yet she wants to come back and make corrections, so she can improve her score.

Students in the blended learning classroom have the flexibility to attempt a content assessment as many times as necessary. The resources students access to develop procedural fluency are online videos and practice, paper/pencil practice provided by the teacher, and/or peer tutoring. Students self-monitor their progress through the course using the blended learning platform, which includes a pacer line. The pacer line indicated where a student should be today to be on pace and to complete a given course by the end of the academic year (Summit Learning, 2018). A teacher commented on student self-direction and pacing saying:

> You must have a solid foundation before you can move on. I do think this is an issue in traditional teaching. Students in traditional teaching must move at my pace and when you move at my pace, the students who do not have the initial foundation get further and further behind.

In the participating district, blended learning model students who took longer to complete the learning for the year could extend their learning into the summer to complete coursework. In the traditional classroom, students are time bound by grading periods potentially eliminating the opportunity for personalized learning.

Unlike the traditional classroom practices, a teacher commented regarding the flexibility in learning in the blended classroom, which allowed students to move forward in learning while still being held accountable for the previous content:

> Yes, ideally students should start at the beginning and build upon their mathematical knowledge; but they are allowed to move past a focus area that is causing then trouble. The students can do that because the platform measures progress, so the student can get this one and get a green [progress measures indicated through red, yellow, and green] without getting an eight on the previous one. The platform will move the mastered focus area up on the timeline and push the one that still needs to be mastered ahead. This allows for more time to be spent on the areas of struggle while still moving through content with the pacer line.

As teachers develop habits of success in their students through blended learning instruction, students exhibit self-direction over their learning and agency in the classroom while exhibiting academic tenacity. Teachers can intervene for students who struggle as the students who are advancing can move on and not be held back as others' are catching up. The key criteria in the classroom structure of self-directed learning seemed to be paramount to ensure student success while the teacher may not be directly involved with each student. A teacher commented on the benefit of student pacing in the blended learning classroom saying:

> The students who are not on pace with everyone else and are slower need to take their time to learn without me telling them it is time to move on. These things are missing from the traditional classroom where everyone has to go at the same pace. Everyone is accountable with the same criteria. We cannot give the students this flexibility [in the traditional classroom]. They have to do the assignment in the same number of days. If students do not complete the assignment, then they lose the grade.

In the traditional classroom, the teacher is dictating student moves while in the blended classroom, students assume ownership of their learning and develop work habits and study skills that will continue contributing to post-secondary readiness.

During classroom observations, teachers consistently demonstrated evidence of the key criteria of articulating a goal for all students related to academic outcomes (100.0%). The medium used for students to articulate the goal was different in some classrooms – with some students recording goals using paper/pencil and others using technology. In several classrooms during observations, students entered a goal into the blended learning platform before the tardy bell. On the teacher dashboard within the blended learning platform, all student-articulated goals populated on one computer screen, so the teacher could view in real time the goals students were setting for themselves and could quickly intervene when the goals were not related to academics. Some teachers using the technology for student goal setting projected all student goals on the screen for all students to see and others made the screen viewable by the teacher only.

According to a teacher during observation, a student benefit to displaying the goals for the class to view was to support students who might be struggling with how to write a goal. Students could modify and revise their goals daily which provided opportunities for students to grow in goal setting. Figure 8 represents the goals page where student input was quickly accessible by the teachers. A teacher during an interview commented, "Goal setting allows students to decide what they need to work on. It makes them responsible for their own work, instead of me telling them what they need to do." One example of a student goal written during observation was: "Today I will pass the content assessment on triangle congruence with an 8/10." Another example of a student goal during the same observation was: "Today I will take notes on 3 more resources from objective 3 in triangle congruence." These examples show how students wrote their goals to focus on specific learning during class. The teachers then held students accountable to completing their goal or creating a plan to continue the goal until completed.

Figure 1. *Student Goal Setting on Teacher Dashboard.*

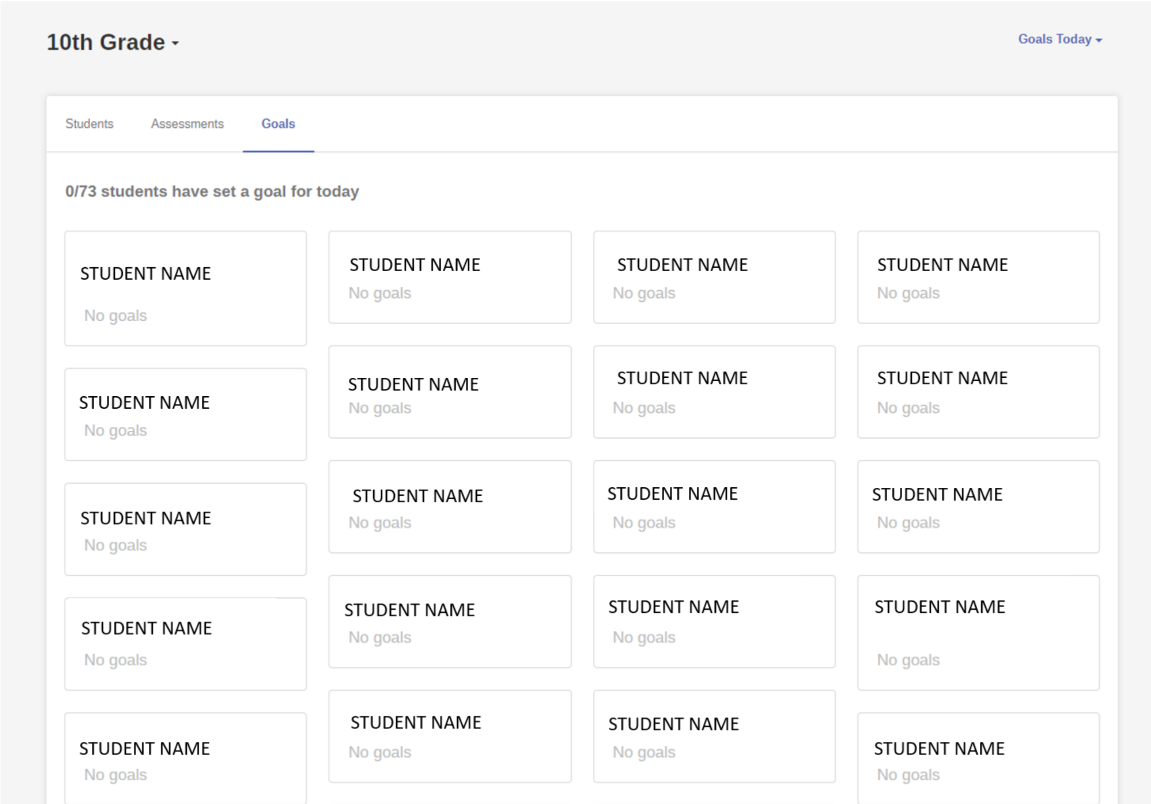

Figure 1. The teacher dashboard in the blended learning online environment provides a place for students to write their daily goals. The screen was captured from the Summit Learning platform used in the participating district (Summit Learning, 2018)

In some cases, teachers provided students with direction to set appropriate goals based on the evidence of student learning available to the teachers. This direction was provided with a PowerPoint slide all students read as they entered the classroom and before they set their individual goals. A teacher made the following comment regarding goal setting during interviews: “I feel that goal setting is not only going to help them (students) in their current school life; but also, in college. If they have that skill, then I feel like they can manage their time more successfully". Another teacher commented on the benefits of goal setting saying, "The students' abilities to set their own goals helps them at the lowest levels and helps them at the highest levels because we're seeing that shift across the board". The shift the teacher was referring to during the interview was toward personalized learning. The teacher is noticing how students do not wait for the teacher to orchestrate the learning; but are demonstrating habits of success by setting their own goals for learning that supports their individual academic outcomes.

During classroom observations, other key criteria for self-directed learning that were evident some of the time were content assessment readiness (57.1%) and content assessment security (57.1%). In the traditional mathematics classrooms, students learn together and they assess together – whether the student is ready to demonstrate mastery or not. In the blended learning classroom, student learning and student assessment is at the pace of the student. During classroom observation, students would let their teacher know when they felt prepared to take a content assessment. The teacher would ask the student how they prepared and would go over the evidence of learning with the student before releasing the content assessment to them. Some evidence that students presented to the teacher were notes over the learning with the practice problems attempted. Assessment security was evidenced by the assessment zones established in the classrooms (see Figures 2 and 3). During teacher interviews, a teacher commented on the student ability to learn and assess at their own pace:

> (Students) know exactly what they need to learn and they can find other people, they talk to each other and they can help each other with their different strengths and weaknesses. Also, it really does help the students because it helps them with their own time management because they do not have to be stuck with me as I'm

teaching the entire class the same thing. One group can be working on one objective while another group is working on objective two.

Figure 2. *Flexible Seating Example One*

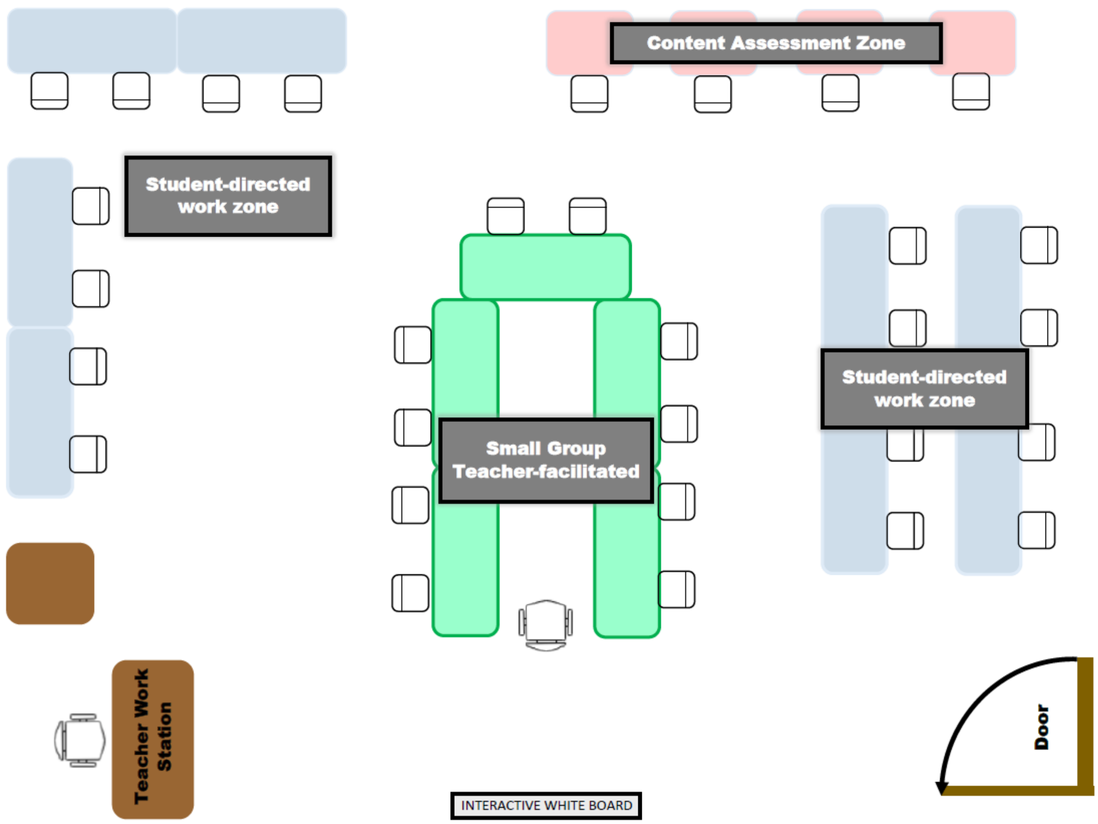

Figure 2. Flexible seating example one observed during self-directed learning during classroom observations. Blue zones indicate where students were self-directed, green zone was where the teacher was facilitating a small group workshop, and red indicates where students independently responded to content assessments within the blended learning online environment.

Figure 3. *Flexible Seating Example Two*

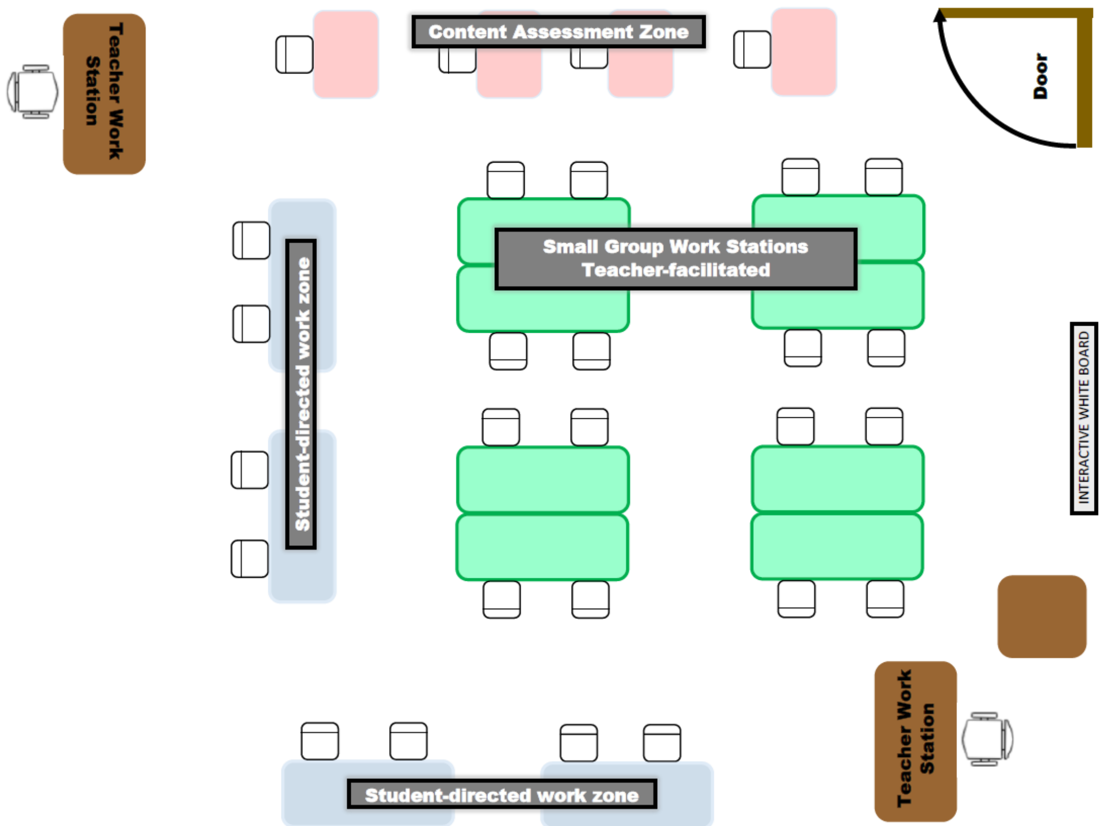

Figure 3. Flexible seating example two observed during self-directed learning classroom observations. Blue indicates where students were self-directed, green indicates where the teacher was facilitating a small group learning, and red indicates where students independently responded to content assessments within the blended learning online environment.

During classroom observations, a key criterion of self-directed learning not observed most of the time was partial group interventions (71.4%); but when it was observed it appeared beneficial to the students. Teachers, following each student's data trail, would choose a small group to conduct a partial group intervention while other students worked together or independently on a task during self-directed learning time. A teacher commented on the ability to pull small groups of students together for targeted support:

> I can bring just three to four (maybe even six kids) together to provide aid for them while other students are still working at their own pace. The content the students are mastering at their own pace may be completely different from what my small group is needing (at the time).

According to the teacher, the students benefit from the intervention while other students can continue at their own pace offering the ability to personalize the learning for each student within the classroom.

During classroom observations, the SDL key criteria of reflection (85.7%) was evident most of the time as students articulated how their own successes and failures had informed their learning processes. During a classroom observation, a student shared a concern with the observer of not being ready for the content assessment. The student continued to share her plan to ensure content assessment readiness that included collaborating with another student and discussing the main objectives with a peer to make certain she was clear on all the learning before attempting the assessment.

Another student, during a different classroom observation, shared with the observer how he attempts the diagnostic assessments first to determine his strengths and weaknesses with the content area; the results of his diagnostic would then dictate how he spent his time studying to prepare to demonstrate mastery on the content assessment. This student behavior is an example of the development of habits of success as the student demonstrates self-direction. One student commented how blended learning was helping her to be self-directed to learn on her own and to prepare her for college. During a classroom observation, when a student was asked how he knows he is ready to take a content assessment, he replied that he took it once already and got zero correct on one objective. The student went on to say that he went back and studied that objective more and now felt better prepared to attempt the content assessment again. According to NCTM (2014), "effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships" (p.10). The blended learning model in the participating district seemed to provide student opportunity to struggle productively during the structure of self-directed learning.

Scheduling and Blended Learning

Disruption of the traditional educational system means that all aspects of the system need to adapt to accept a new model for learning (Christensen, Horn, & Staker, 2013). Traditionally a high school schedule includes the time periods for each scheduled period of the day where students rotate between subjects with the schedule varying slightly on days when homeroom is included in the schedule. In the traditional schedule, time is the constant and achievement becomes the variable – resulting in all students not performing at the same level in the same amount of given time (NCTM, 2018). Blended learning scheduling in the participating district did not define time and achievement with the same lens and class periods are not defined by subject; but rather by blended learning structure. During an interview, a teacher commented on this flexibility found in the blended classroom when time was the variable:

> One thing I had to change was that I cannot just concentrate on the lesson that we are doing today or the lesson that we are doing next week. I need to know what's ahead. I need to know all the focus areas because there are some students who are working ahead and when they ask me questions, I need to be prepared.

Each campus and grade level team have the freedom to define the schedule reflecting the amount of time to be spent addressing each blended learning structure within the model and is evidenced in the three schedules below. Figure 4 is the 10th grade team schedule for the blended learning classroom at Site A. Figure 5 is the Site B 10th grade team schedule for the blended learning classroom and Figure 6 is the Site C 10th grade team schedule for blended learning.

Figure 4. *Site A Blended Learning Bell Schedule for Sophomore Team*

GLT2- Sophomores	Time	Period	Monday	Tuesday	Wednesday	Thursday	Friday
	7:15-8:09	1	SDL/Mentoring	CT	CT	CT	CT
	8:15-9:09	2	SDL/Mentoring	CT	CT	CT	CT
	8:15-8:21		Pledge/Announcements				
	9:15-10:03	3	SDL/Mentoring	CT	CT	SDL	SDL
	10:09-10:57	4	Conference				
	10:57-11:52	LUNCH	Lunch/Interventions (25 min)				
	11:58-12:47	5	SDL/Mentoring	CT	CT	CT	CT
	12:53-1:41	6	GLT Planning				
	1:47-2:35	7	SDL/Mentoring	CT	CT	CT	CT
	GLT - grade level team		SDL- self-directed learning		CT- concept unit time		

Figure 4. Site A sophomore grade level team determined the when to schedule the three structures of blended learning. GLT means grade level team, SDL means self-directed learning, and CT means concept unit time.

Figure 5. Site B Blended Learning Bell Schedule for Sophomore Team

GLT2-Sophomores	Time	Period	Monday	Tuesday	Wednesday	Thursday	Friday
	7:15-8:00	1	SDL	SDL	CT	CT	Mentoring
	8:05-8:50	2	SDL	SDL	CT	CT	Mentoring
	8:55-9:40	3	SDL	SDL	CT	CT	Mentoring
	9:45-10:05	INTERVENTION	SDL	SDL	CT	CT	Mentoring
	10:10-12:05	4	SDL	SDL	CT	CT	Mentoring
	11:40-12:05 ?	Lunch	SDL	SDL	CT	CT	Mentoring
	12:10-12:55	5	SDL	SDL	CT	CT	Mentoring
	1:00-1:45	6	SDL	SDL	CT	CT	Mentoring
	1:50-2:35	7	SDL	SDL	CT	CT	Mentoring
	GLT - grade level team		SDL- self-directed learning		CT- concept unit time		

Figure 5. Site B sophomore grade level team determined the when to schedule the three structures of blended learning. GLT means grade level team, SDL means self-directed learning, and CT means concept unit time.

Figure 6. Site C Blended Learning Bell Schedule for Sophomore Team

	Period	Monday	Tuesday	Wednesday	Thursday	Friday
GLT2-Sophomores	1	SDL/Mentoring 7:15-8:05	CT 7:15-8:05 *I-[8:05-8:20]*	CT 7:15-8:05	SDL 7:15-8:05	CT 7:15-8:05
	2	SDL/Mentoring 8:10-8:55	CT 8:25-9:10	CT 8:10-8:55 *I-[8:55-9:10]*	SDL 8:10-8:55	CT 8:10-8:55
	3	SDL/Mentoring 9:00-9:45	CT 9:15-10:00	CT 9:15-10:00	SDL 9:00-9:45 *I-[9:45-10:00]*	CT 9:00-9:45
	4		*GLT10 Conference*			
	HR	10:40-11:10				
	Lunch-5	SDL/Mentoring 11:15-12:55	CT 11:10-12:50	CT 11:15-12:55	SDL 11:15-12:55	CT 11:15-12:55
	6	SDL/Mentoring 1:00-1:45	CT 12:55-1:40	CT 12:40-1:25 *I-[1:25-1:40]*	SDL 12:40-1:25	CT 1:00-1:45
	7	SDL/Mentoring 1:50-2:35	CT 1:45-2:35	CT 1:45-2:35	SDL 1:30-2:15 *I-[2:15-2:35]*	CT 1:50-2:35
GLT - grade level team		SDL- self-directed learning		CT- concept unit time		I-intervention

Figure 6. Site C sophomore grade level team determined the when to schedule the three structures of blended learning. GLT means grade level team, SDL means self-directed learning, and CT means concept unit time.

Although slight differences exist between schedules (shown above), some things remain consistent across all three campuses. All three campuses embed time for grade level teams to meet in collaboration regarding student success and implementation of the blended learning model ensuring learning is personalized for all students. Each of the three campuses embed intervention time into each day to address the needs of individual students whose data indicated they are falling behind their peers in content development. Intervention time was indicated as a separate dedicated time allotment on each individual campus blended learning schedule. Each campus also schedules the specific structures identified within the Summit learning model. According to Summit learning (2017), students should have self-directed learning time, concept unit time, and mentor time built into the daily schedule. Each campus schedule reflects time spent in self-directed learning (yellow cells), concept unit time (blue cells), and one-on-one mentoring (green cells).

The blended learning platform housed the curriculum, assessments, and instructional materials used in the classrooms. Student grades are collected in the online platform attributed to both conceptual development and procedural fluency. As students produce evidence of learning within the blended learning classroom, 70% of the grade was determined by concept development during concept unit time with the remaining 30% of the grade determined by procedural fluency (developed primarily during self-directed learning). This breakdown should also be reflected in the amount of time spent in the classroom on each of the three structures; however, the schedules reflect a disproportionate amount of time spent on procedural fluency with the same disproportion reflected in the classroom observations. For example, during observations at Site A, self-directed learning was observed seven times as compared to conceptual development (three times). A traditional classroom characterized the conceptual development observations where students worked collaboratively to achieve the same conceptual understanding. The self-directed learning observations looked nothing like the traditional batched-learning in that students were engaged in different tasks with different outcomes creating a dynamic and multi-faceted learning environment personalized for each individual student.

The differences between self-directed learning and concept unit development were evidenced through student behaviors including (a) students working independently through focus areas to develop procedural fluency and (b) students working together to develop conceptual understanding. Students developed conceptual understanding as they worked together in collaboration to discuss the developed concept. According to NCTM (2014), "effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems" (p. 10). The reduced emphasis on conceptual development could be an explanation for the lack of statistically significant quantitative evidence in the blended learning classroom; but is also evidence of the change process. Change is not an event; but rather takes time (Frontier & Rickabaugh, 2014).

Flexibility and Blended Learning

Each blended learning classroom observation resulted in a different classroom configuration with desks moved regularly to meet the needs of the students and the structure. Based on observational data, desks moved fluidly in the classroom as observations in the same classroom at different times resulted in difference classroom configurations. However, the definition of spaces within the classroom were consistent across campuses. Figure 2 and Figure 3, in the previous section, illustrated the learning zones during one classroom observation with specifically defined spaces where students worked to meet their individual needs. Some students were gathered about the teacher in a small group with others working independently or in pairs and others taking content assessments individually. This specific configuration was observed during self-directed learning where the teacher was holding a small group workshop to address a common misconception held by the group of students identified for small group support. A teacher commented on the advantages of flexibility of the blended classroom:

> I would miss working with my struggling students directly in the traditional classroom. Having the flexibility to work with those students directly in the (blended) classroom and having that time knowing that the other students are going to be fine is a benefit to blended learning.

During the interview, the teacher eluded to the lack of freedom the teacher perceived to have hindering the ability to tailor instruction to meet the needs of each individual learning. The lack of freedom expressed seemed to be connected to the lack of time given in the traditional setting for authentic personalization of learning. The perceived lack of time could be connected to the pressure high school teachers feel regarding post-secondary readiness and performance on high stakes tests when teaching in the traditional classroom.

During teacher interviews it was evident that teachers felt the flexibility provided time for them to intervene with struggling students during class time while expectation of learning was still the goal of the students working independently. Another teacher commented on the ability of students to support one another during the class period:

> I get to learn my students a little bit better and by seeing the students collaborate with one another is not something you see in a traditional classroom. I literally have students come up to me and ask if they can tutor another student. To see a student wanting to tutor another student is just wonderful because you know that

> the one who's doing the tutoring truly understands what he's doing and you know he's going to help that student to be more successful.

Teachers in the blended classroom are juggling multiple concepts at one time as students are at different places in their mathematics-learning journey expanding the flexibility in the learning space. Teachers enter the blended learning classroom at the beginning of the year with the entire year's curriculum already planned out including all the resources for instruction and assessment. Curriculum development and planning was conducted throughout the summer so that when teachers enter the blended learning classroom in the beginning of the year they do not spend time curating the resources necessary to teach each unit of study. This allows teachers to focus their energy during the school year on supporting each individual student offering equitable outcomes for all. Teachers in the blended learning classroom understand that time is the variable allowing students to be in multiple points of the curriculum at the same time. For instance, one teacher commented, "I can help a student who is working on unit five as well as a student who is working on unit one." The same teacher mentioned the benefit of flexibility to personalize the learning for students:

> Every student works at their own pace. Background knowledge or how they perceive content is very helpful for me [when working with individual students]. Some students may be working ahead, some students may be working behind, while some students just want to remain with the pacer line. The best part is no matter where the students are working, they do not have to skip content just to keep up with the class.

The blended learning platform is a tool that allows students and teachers to view the entire year as a timeline (see figure 7). A pacer line indicates for a student where they should be to complete the year on time allowing the student to self-monitor where they are on their learning journey throughout the year. The blended learning calendar extended to the end of the academic year and was not truncated to accommodate state testing; therefore, students continued to learn new content even after state testing. This could potentially be problematic; however, if students have developed the ability to problem-solve throughout the blended learning model then the test should not be an issue as students developed thinking and reasoning abilities throughout the course of the year.

Figure 7. *Student Dashboard in the Blended Learning Platform*

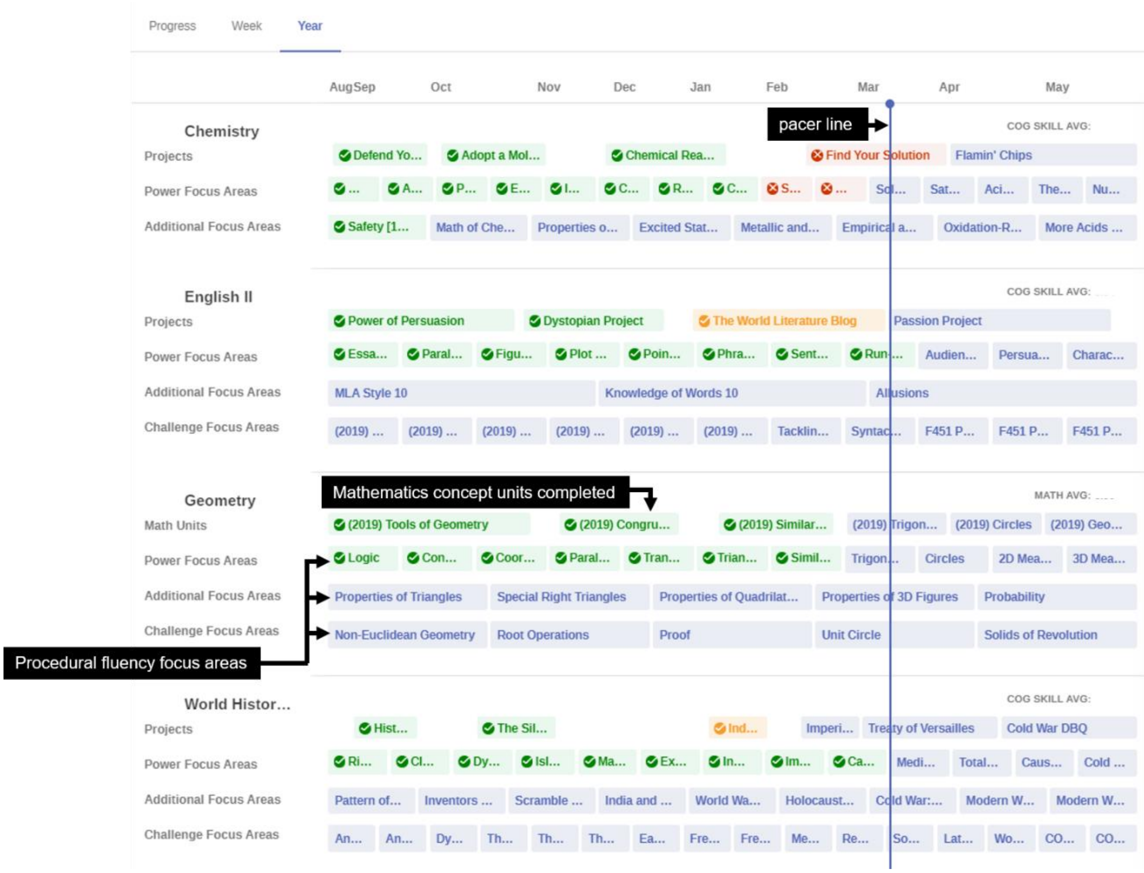

Figure 7. The student dashboard in the blended learning online environment provides a place for students to view and pace their learning throughout the year. Elements included on the dashboard are all projects and mathematics concept units and all focus areas (power, additional, and challenge) assigned by course for the academic year. The screen was captured from the Summit Learning platform used in the participating district (Summit Learning, 2018)

Classroom observations during mentor check-ins did not yield a different classroom configuration – only the position of the teacher became somewhat fixed behind the teacher desk while students engaged in self-directed learning (see Figure 2 on page 112 and Figure 3 on page 113); however, the flexibility within the blended learning classroom was also observed during concept unit development. Figure 8 and Figure 9 illustrate the learning zones observed during a concept unit development day. In one classroom during observation, the teacher spent a few minutes launching the lesson to the whole group and then students worked in small groups to develop understanding and make meaning of the content. The teacher floated around the room in a rolling chair becoming a part of each small group to check for understanding and answer any questions students had regarding procedures or content. On this day, two students were seated in the student-directed work zone; but were working in tandem on the assignment. The observed assignment was completed with paper and pencil (as opposed to using technology). The use of technology depended on the observed structure where all content assessments were completed using technology, whereas conceptual development was completed using paper and pencil. The flexibility of the learning space provided students the opportunity to work in partners or in small groups with the teacher facilitating the learning with all groupings. A teacher commented on the freedom felt while teaching in the blended learning classroom as opposed to the traditional classroom and viewing all students the same:

> I've had to work with students who work well with manipulatives and work with students who don't. Whenever they are getting confused on what the concept is, I have had to actually bring out a three-dimensional object and have them put their hands on it. After that, it was like a lightbulb clicked. I think with this type of learning for this type of learner you get to provide these opportunities (in blended

learning). Maybe you can replicate these experiences in the traditional classroom as well; but when I used manipulatives in the traditional classroom, it was with the whole class. Some of the kids were like this isn't working for me and for some students it was great and wonderful. I think being able to differentiate is what makes (blended learning) great.

Figure 8. *Flexible Seating Example Three*

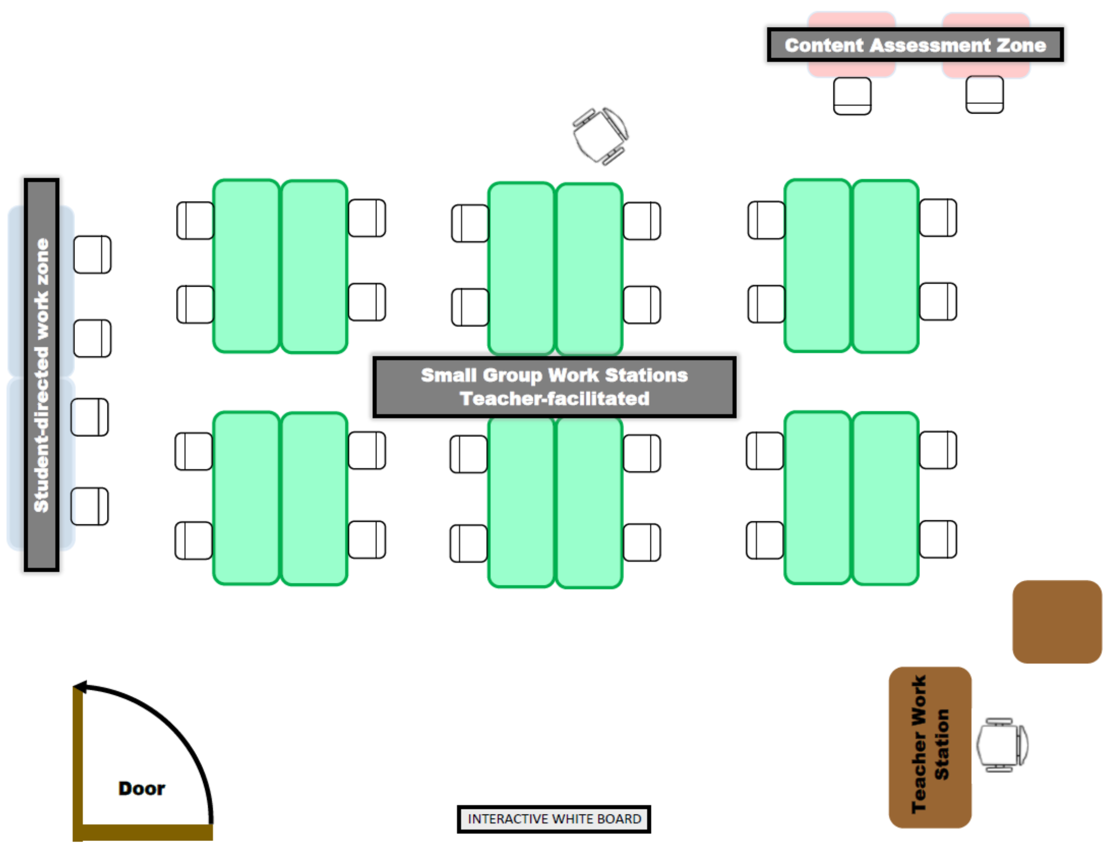

Figure 8. Flexible seating example three observed during concept unit development.

Figure 9. *Flexible Seating Example Four*

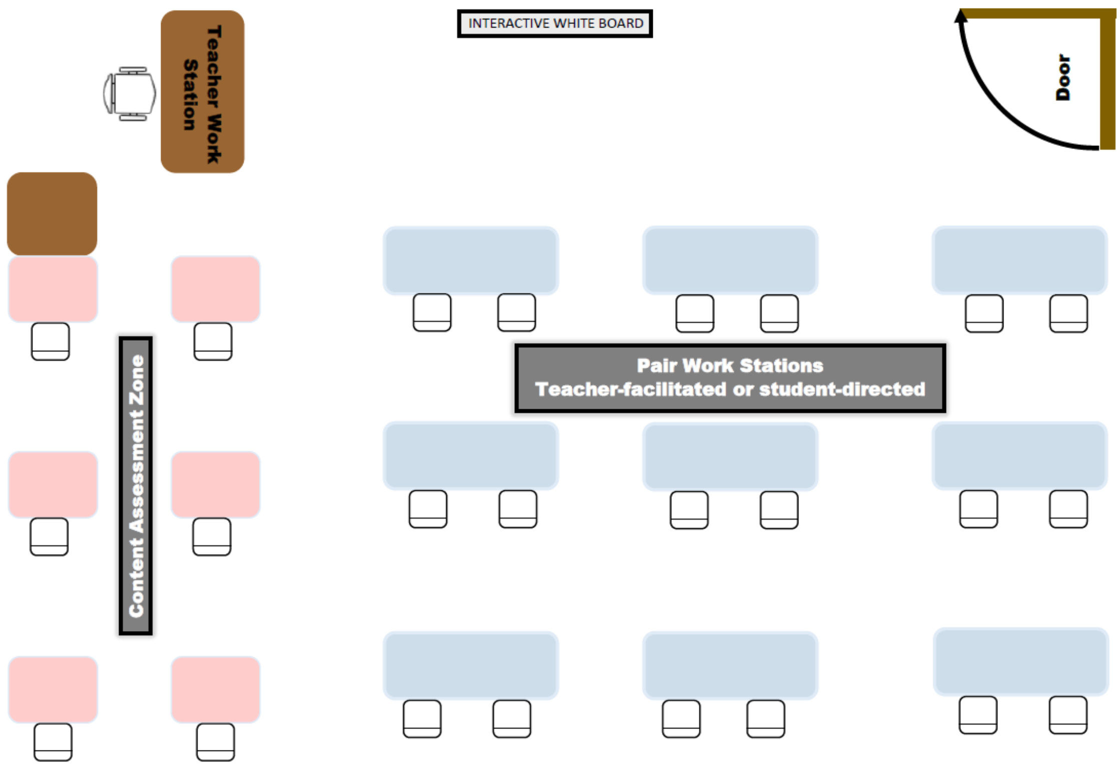

Figure 9. Flexible seating example four observed during concept unit development

Students collaborate to build conceptual understanding while the teacher acts as the facilitator of learning. During classroom observations, students could be heard discussing mathematics learning engaged in discourse to develop understanding. A note was recorded during one observation that students were discovering the algebraic notation associated with coordinate transformations as they discussed with their peers while the teacher moved about the classroom scaffolding as needed. According to NCTM (2014), "effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments" (p. 10). During teacher interviews, a teacher commented, "My role is often described as a facilitator – which is a great aspect of this model. I see myself as a tutor where the students have some knowledge and I'm there to correct the misconceptions." Another teacher remarked that facilitating learning allows the teacher to be "an observer – which means to be continuously formatively assessing (students) at all times". During classroom observations, student discourse about content was rich and permeated the small groups. Students explained their understanding and asked clarifying questions. Students articulated the work they were doing and provided evidence using academic vocabulary indicating the conversation was developing conceptual understanding and not off topic. As an example, during one classroom observation, students were investigating exponential functions using an online graphing tool activity. Students were talking and discussing conclusions based on their observations of the data presented before the teacher facilitated a debate of the conclusions. The online graphing activity had a feature that provided space for students to write their conclusions. The student conclusions were then displayed using an anonymizer to protect student identity while providing the class the opportunity to debate.

The observable and teacher perceived evidence from classroom observations and teacher interviews provided evidence of the dynamic classroom environments that define the blended learning model of instruction implemented in the participating district. Learning is personalized as teachers implement the three structures of the model and students engage with one another and mathematics concepts in an innovative way as teachers strive to engage all learners in the study of mathematics with the potential to one day influence post-secondary readiness and academic achievement in mathematics.

Summary of Findings

Progress toward influencing post-secondary readiness in mathematics remains a work in progress. The current study did not find any statistically significant differences in post-secondary readiness as measured by PSAT 2018 between a matched sample of traditional learning students and blended learning students in a large urban school district located in the southeast region of Texas. The results indicated that whether receiving traditional instruction or blended learning instruction students were not reaching the PSAT grade level benchmark indicating post-secondary readiness in mathematics. However, when analyzing mathematics achievement, the result depended on the site with one site not indicating participation in blended learning influencing mathematics achievement while another campus the influence was statistically significant. The third site analysis revealed participating in blended learning adversely influenced mathematics achievement- indicating the teacher in the classroom implementing the instruction is a significant factor in mathematics achievement.

The descriptive analysis of the observable and teacher perceived characteristics of the blended classroom provided the most significant findings. The model engaged students in learning with the mathematical teaching practices (NCTM, 2014) embedded throughout the structures of the blended learning environment moving away from the traditional factory model of instruction. According to Frontier and Rickabaugh (2014), a question to ask would be “If we’ve engaged in significant change efforts; but students don’t have a significantly different learning experience, has anything really changed” (p. 27)? The implementation of the blended learning model of instruction has changed the student learning experience, but the implementation is still in its infancy in the participating district. Therefore, it is the recommendation of the researcher to replicate this study as the change effort becomes a part of the district culture and becomes sustainable through the emergence of consistent implementation district-wide.

Conclusions

This chapter presented the results of the quantitative and qualitative data analysis of this study. In the next chapter, this study’s findings were discussed by comparing and contrasting with prior studies documented in the research literature. Additionally, the implications of this study's results were discussed with consideration toward implementation of a blended learning model. Future research suggestions were also discussed.

CHAPTER V:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning. Personalized learning through blended learning has emerged as an educational practice with promising potential to close the academic achievement gap in mathematics and produce post-secondary ready learners. Archived PSAT and STAAR data were analyzed using independent t-test, Chi-squared test of independence, cross tabulations, and paired samples t-test. A sample of blended learning students in a large urban school district in the southeast region of Texas were individually matched with a sample of traditional learning students. Blended learning teachers in the same school district participated in classroom observations and interviews. This chapter presents a summary of the findings of the quantitative and qualitative data analysis of the study, the implications of the findings on high school mathematics practice and concludes with recommendations for future research.

Summary

The purpose of this study was to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning. This study addressed the following research questions:

1. Does participation in blended learning influence post-secondary readiness in mathematics?
2. Is there a relationship between blended learning participation and post-secondary readiness?
3. Is there a statistically significant gain in post-secondary readiness when participating in blended learning from PSAT 2017 to PSAT 2018?

4. Does participation in blended learning influence academic achievement in mathematics?
5. Is there a relationship between blended learning participation and mathematics achievement?
6. What are the observable and teacher perceived characteristics of the blended learning classroom?

Mathematics Post-Secondary Readiness

Research Question 1. Findings from this study indicated participation in blended learning did not influence mathematics post-secondary readiness when measured using PSAT 2018. Because the blended learning model of instruction used in this study focused on conceptual development as one of three structures in the model, the results contradict Houser and An (2015) who determined students who were most likely to be college ready in mathematics when mathematics was developed conceptually. One reason that explains the contradiction could be that the blended learning model is still in its infancy in the participating district. Students in blended learning are provided explicit instruction to develop conceptual understanding; however, the outcomes have not yet influenced post-secondary readiness in mathematics. Change takes time; therefore, when emerging practices become the norm in the blended learning classroom the outcomes could improve.

Research Question 2. Findings from this study indicated no statistically significant relationship existed between model of instruction and mathematics post-secondary readiness. The findings of this study contradict those of Henry (2018) who found that blended learning had a significant impact on graduation rates. Zelkowski (2011) explained the difference between being college prepared and college ready. When students are college prepared they have met the requirements to graduate from high school; however, graduation was not an indication that students were ready to take credit-bearing courses in college. The difference between college preparedness and college readiness could explain the contradiction in results. Another contradiction to the findings of the current study is with the results of Fagella (2018a) who reported blended learning students outperformed their non-blended learning peers when measured on post-secondary readiness in mathematics. Several factors that could explain the contradiction in results could be the current study used a matched sample of grade ten students from a large, urban school district using PSAT to measure post-secondary readiness whereas Fagella studied grade eight students from a small urban school district and measured post-secondary readiness using the Partnership for College and Careers (PARCC). Middle grade students are more closely connected to the knowledge and skills required to demonstrate college readiness (Curry, 2017) which could explain why grade eight students were more successful than grade 10 students.

Demographics. Findings from this study indicated no statistically significant relationship between model of instruction and mathematics post-secondary readiness when examining among race/ethnicity. These findings are in agreement with Houser and An (2015) who found the combination model including academics and demographics did not prove to predict college readiness. Findings from this study indicated no statistically significant relationship between model of instruction and mathematics post-secondary readiness when examining among gender; however cross tabulation results indicated some differences between student groups reaching the grade level benchmark. Cross tabulation results indicated females are outperforming males when they participated in blended learning indicating that results are emerging that potentially influence the gender achievement gap. The findings of this study aligned with Atahuahene and Russell (2016) who found female students to be better prepared for select college-level mathematics courses than male students. These findings, however, contradict Royster, Gross, and Hochbein (2015) who determined males were more likely to be college ready in mathematics than females. One reason for the variance in the results could be that neither of the above studies focused on model of instruction as a factor of influence.

Research Question 3. Findings from this study indicated no statistically significant mean difference in post-secondary readiness when participating in blended learning. The findings of this study contradict Faggella (2018b) who found blended learning students after two years of implementation scored 108 points above the state average on SAT. One reason for the contradiction in results could be that the current study used a sophomore cohort of students to measure post-secondary readiness, whereas Fagella (2018b) used grade 8 students. Curry (2017) reported that, "most of the math that is required of students before beginning college courses and the math that most enables students to be successful in college courses in not high school mathematics; but middle school mathematics" (p. 63). It is possible that grade eight students are more suited to demonstrate college readiness on exams because middle grade students are more closely connected to the necessary mathematical knowledge and skills.

Mathematics Achievement

Research Question 4. Findings from this study indicated participation in blended learning did not influenced mathematics achievement when analyzing the three participating sites; but digging deeper revealed results varied by campus site. The varied results by campus align with Brown-Jeffy (2009) who determined what happens inside the classroom and inside the schools significantly affects student outcomes in mathematics. The findings of this study also align with Yu and Singh (2016) who determined teaching approaches in mathematics significantly affect student achievement. The blended learning model implemented in classrooms in this study focus on conceptual development in mathematics as one of the three structures of the model. The inclusion of conceptual development as a structure of blended learning instruction also indicated the findings of this study contradict Yu and Singh (2016) who determined that conceptual development in mathematics had a positive effect on mathematics achievement. Desimone et al. (2005) also reported a positive relationship between conceptual teaching and mathematics achievement. The implementation of the blended learning model of instruction produced different results for the three participating campuses. Inconsistency of evidence of the key criteria for each of the three blended learning structures could be the factor influencing a consistent positive relationship between conceptual development and mathematics achievement in the current study. As teachers develop their understanding of the blended learning model through time and improve implementation, then expectations of mastery may increase as the personalization of learning begins to become the norm.

Research Question 5. Findings from this study indicated no statistically significant relationship between model of instruction and mathematics achievement when analyzing the data for all three participating campuses combined. Results varied when analyzing campus sites individually. Site A indicated no statistically significant relationship existed between model of instruction and mathematics achievement; however, Site B yielded a different result indicating a statistically significant relationship between model of instruction and mathematics achievement, as well as Site C also indicated a statistically significant relationship between model of instruction and academic achievement. The inconsistent findings between model of instruction and mathematics achievement by participating campus align with Brown-Jeffy (2009) who found that significant differences existed between schools and mathematics achievement.

Demographics. Findings from this study indicated no statistically significant relationship between model of instruction and mathematics achievement when analyzing race/ethnicity; however, some cross tabulation differences existed. A larger percentage of White/Caucasian blended learning students mastered grade level performance (approximately 67%) than Black/African American blended students (approximately 13%) and Hispanic blended learning students (approximately 19%). Of the blended learning students who met grade level performance, approximately 33% were White/Caucasian and Black/African American while approximately 32% were Hispanic. Students are not performing at the same level when examining among race/ethnicity. The achievement gap evident in the current study when examining among race/ethnicity aligns with Brown-Jeffy (2009) who determined race to be a crucial factor in mathematics achievement.

Findings from this study indicated no statistically significant relationship existed between model of instruction and mathematics achievement when analyzing gender; however, some slight differences were indicated in the cross tabulation results. Females outperformed males at the 'meets grade level' benchmark with approximately 38% of the students who were female and approximately 33% of the students who were male. This finding aligns with Atauhene and Russell (2016) who determined female students were outperforming male students in some college courses, such as algebra and trigonometry, developmental course, and in statistics. This finding also aligns with Wheeler and Bray (2017) who determined female students were more likely to pass a first-year college mathematics course than male students.

Blended Learning

Research Question 6. Findings from the classroom were analyzed using an inductive coding process based on classroom observations and teacher interviews.

Findings were organized into three major themes: (a) blended learning classroom structures, (b) scheduling and blended learning, and (c) flexibility and blended learning. The theme of scheduling and blended learning was sub-categorized to include: (a) 1:1 mentor check-ins, (b) math concept units, and (c) self-directed learning (SDL). The results were consistent across all three implementing campuses as teachers expressed the benefits of participating in blended learning on student participation and productive engagement in the classroom.

Classroom observations indicated teachers addressed all three classroom structures. Classroom observational data indicated implementing teachers were inconsistent when addressing the key characteristics of each of the blended learning structures. The implementation inconsistency could explain why blended learning is not influencing post-secondary readiness and why academic achievement results differed by campus site. All three blended learning structures were observed during classroom visits; therefore, as implementation fidelity increases the hope would be that post-secondary readiness and academic achievement gains in mathematics would also increase. Students were engaged in academic tasks that differed depending on individual academic need providing evidence of personalization in the mathematics classroom. Duncan (2013) described personalized learning as a tailored approach that is paced and addressed the interest of individual students. The classroom diagrams provided evidence of how the blended learning classrooms were arranged to support student personalization and learning tasks that were tailored to meet the individual student rather than the mass of students.

Teachers consistently commented on how they facilitated learning in the classroom and the positive feelings regarding the ability to mentor students. Student-centered learning was consistent during classroom observations when teachers were not the sage on the stage. Students shared during classroom observation how they were free to move at their own pace instead of being paced by the teacher. Zimmerman, Bandura, and Martinez-Pons (1992) reported that self-directed learning embraced thinking skills and self-regulation of three factors: motivation, learning environment, and self-directedness. Teachers were observed developing the habits of success in students promoting their motivation to learn mathematics by providing a positive learning environment that included self-directed learning. Teachers supported students by facilitating the development of content knowledge and skills as well as coaching students to develop both interpersonal skills and intrapersonal skills.

The blended learning model of instruction provided rigorous coursework through embedding the eight mathematical teaching practices (NCTM, 2014) into the three blended learning structures and provided opportunities to personalize learning for every student. Increasing student performance in mathematics to influence post-secondary readiness and academic achievement in mathematics is critical. “The assumptions, expectations, beliefs, behaviors and structures that have guided educational practice throughout the history of this country and others are inadequate to meet the present challenges” (DuFour, DuFour, Eaker, & Karhanek, 2010, p. 22). Blended learning is a model of instruction poised to break the mold and meet the needs of 21st century learners.

Implications

As a result of this study’s examination of the influence of blended learning on post-secondary readiness in mathematics, the implications for change are on the horizon as we strive to personalize learning for every student to ensure equitable educational outcomes. For districts, this research revealed student achievement was influenced before post-secondary readiness; but only pockets of success emerged during the beginning years of implementation of the blended learning model of instruction. As the development of the model permeates schools in the participating district, careful review of the content embedded within the model should be considered to ensure direct alignment to the essential outcomes necessary for students to master mathematics content; but also to ensure the outcomes are aligned with mathematics post-secondary readiness. Continued observations to measure the implementation of the key characteristics within each of the three structures followed by coaching and professional development to support teachers as they continue on this journey to reach all learners. For teachers, this research revealed that providing students with opportunity to develop both conceptually as well as procedurally in mathematics through a blended learning model of instruction engaged students in learning and allowed them to take ownership of their learning by allowing time to be the variable in the hope that outcomes will become the constant for all students.

Recommendations for Future Research

Curry (2017) describes the results of a two-and-a-half year National Center on Education and the Economy (NCEE) study addressing what it really means to be college and work ready. "What they discovered is most of the math that is required of students before beginning college courses and the math that most enables students to be successful in college courses is not high school mathematics; but middle school mathematics" (Curry, 2017, p. 63). A longitudinal study beginning in the middle school grades and ending when the cohort of students graduate high school might be a better measure of the influence of blended learning on post-secondary readiness as well as academic achievement. If students begin developing habits of success while in middle school through personalization of learning in the blended learning classroom, then the outcomes might be positive when measuring the influence of blended learning on post-secondary readiness and academic achievement in mathematics.

REFERENCES

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment*, *27*(3), 197–205. doi:10.1177/0734282908330580

Atuahene, F., & Russell, T. A. (2016). Mathematics readiness of first-year university students. *Journal of Developmental Education, 39*(3). 12.

Basham, J. D., Hall, T. E., Carter, R. A., & Stahl, W. M. (2016). An operationalized understanding of personalized learning. *Journal of Special Education Technology*, *31*(3), 126–136. doi:10.1177/0162643416660835

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. San Francisco, CA: Jossey-Bass.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of railside school. *Teachers College Record*, *110*(3), 608-645.

Brown-Jeffy, S. (2009). School effects: Examining the race gap in mathematics achievement. *Journal of African American Studies*, *13*, 388–405. doi: 10.1007/s1211-008-9056-3

Chao, T., Chen, J., Star, J. R., & Dede, C. (2016). Using digital resources for motivation and engagement in learning mathematics: Reflections from teachers and students. *Digital Experiences in Mathematics Education*, *2*(3), 253–277. doi:10.1007/s40751-016-0024-6

Christensen, C. M., Horn, M. B., & Staker, H. (2013). *Is k-12 blended learning disruptive? An introduction to the theory of hybrids*. Redwood City, CA. Retrieved from https://eric.ed.gov/?id=ED566878

College Board. (2017). *K-12 educator brief: The college and career readiness benchmarks for the SAT suite of assessments*. Retrieved from https://collegereadiness.collegeboard.org/pdf/educator-benchmark-brief.pdf

College Board. (2018). *More than 2 million students in the class of 2018 took the SAT, highest ever*. Retrieved from https://www.collegeboard.org/releases/2018/more-than-2-million-students-in-class-of-2018-took-sat-highest-ever

Conley, D. T., & French, E. M. (2014). Student ownership of learning as a key component of college readiness. *American Behavioral Scientist, 58*(8), 1018–1034. doi:10.1177/00027642135232

Cross, D. I., Hudson, R. A., Adefope, O., Lee, M. Y., Rapacki, L., & Perez, A. (2012). Success made probable: Creating equitable mathematical experiences through project-based learning. *Journal of Urban Mathematics Education, 5*(2), 55-86.

Curry, D. (2017). Where to focus so students become college and career ready. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 6*(1), 62.

Dabbagh, N., & Kitsantas, A. (2005). Using web-based pedagogical tools as scaffolds for self-regulated learning. *Instructional Science, 33*(5/6), 513–540. doi:10.1007/s11251-005-1278-3

Desimone, L. M., Smith, T., Baker, D., & Ueno, K. (2005). Assessing barriers to the reform of U.S. mathematics instruction from an international perspective. *American Educational Research Journal, 42*(3), 501–535. doi:10.3102/00028312042003501

Dweck, C. (2006). *Mindset: The new psychology of success*. New York, NY: Random House.

Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher, 44*(4), 237-251. doi:10.3102/0013189X15584327

DuFour, R., DuFour, R., Eaker, R., & Karhanek, G. (2010). *Raising the bar and closing the gap: Whatever it takes*. Bloomington, IN: Solution Tree Press.

Duncan, A. (2013). Empowering learners in the 21st century. *The Education Digest*, *79*(4), 67.

Evans, R. (2005). Reframing the achievement gap. *The Phi Delta Kappan*, *86*(8), 582–589.

Faggella, L. (2018a). Case study: Woonsocket students own learning, outperform peers. Retrieved from https://blog.summitlearning.org/2018/05/case-study-woonsocket-education-department/

Faggella, L. (2018b). Case study: Mentoring sets Blackstone Valley students on path to college. Retrieved from https://blog.summitlearning.org/2018/05/case-study-blackstone-valley/

Flores, A. (2007). Examining disparities in mathematics education: Achievement gap or opportunity gap? *The High School Journal*, *91*(1), 29–42. doi:10.1353/hsj.2007.0022

Fosnot, C. T. (2005). *Constructivism: Theory, perspectives, and practice* (2nd ed.). New York, NY: Teachers College Press.

Frontier, T., & Rickabaugh, J. (2014). *Five levers to improve learning*. Alexandria, VA: ASCD Publications.

Gutiérrez, R. (2000). Advancing African American, urban youth in mathematics: Unpacking the success of one math department. *American Journal of Education, 109*(1), 63-111. doi:10.1086/444259

Hall, G. E., & Hord, S. M. (1987). *Change in schools: Facilitating the process*. Albany, NY: State University of Albany Press.

Hambleton, R. K., & Swaminathan, H. (1985). *Item response theory: Principles and applications.* Boston, MA: Kluwer Boston.

Henry, D. (2018). *The impact of blended learning: The new normal in education* (Order No. 10747254). Available from ProQuest Dissertations & Theses Global. (2029172770).

Hong, C., Chen, C., Chang, M., & Chen, S. (2007). Intelligent web-based tutoring system with personalized learning path guidance. *Seventh IEEE International Conference on Advanced Learning Technologies (ICALT 2007)*, 512–516. doi:10.1109/ICALT.2007.167

Houser, L. C., & An, S. (2015) Factors affecting minority students/ college readiness in mathematics. *Urban Education, 50*(8), 938–960. doi: 10.1177/0042085914536998

Hwang, N., Reyes, M., & Eccles, J. S. (2016). Who holds a fixed mindset and whom does it harm in mathematics? *Youth & Society, 51*(2), 247-267. doi:10.1177/0044118X16670058

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14-26.

Kallick, B., & Zmuda, A. (2017). *Students at the center: Personalized learning with habits of mind*. Alexandria, VA: ASCD.

Larson, M. R., & Kanold, T. D. (2016). *Balancing the equation: A guide to school mathematics for educators and parents*. Bloomington, IN: Solution Tree Press.

Marshall, D. (2018). *Blended learning as an instructional strategy to improve academic performance* (Order No. 10830542). Available from ProQuest Dissertations & Theses Global. (2065057504).

McKown, C., & Weinstein, R. S. (2008). Teacher expectations, classroom context, and the achievement gap. *Journal of School Psychology*, *46*(3), 235–261. doi:10.1016/j.jsp.2007.05.001

McNeil, K. (2018). Case study: Closing achievement gaps in math and reading. Retrieved from https://blog.summitlearning.org/2018/02/case-study-aspen-valley/

Minsky, C. (2016). College degrees with the highest salary potential. Retrieved from https://www.timeshighereducation.com/student/news/college-degrees-highest-salary-potential

National Center for Education Statistics. (2015a). *The nation's report card: Mathematics 2015: National assessment of educational progress at grades 4, 8, and 12.* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

National Center for Educational Statistics. (2015b). NAEP – achievement gaps. Retrieved from https://nces.ed.gov/nationsreportcard/studies/gaps/

National Council of Teachers of Mathematics. (2018). Catalyzing change in high school mathematics: Initiating critical conversations. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all* (1st ed.). Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. Washington, DC: The National Academies Press. Retrieved from https://doi.org.10.17226/13398

OECD (2013). *Lessons from PISA 2012 for the United States, strong performers and successful reformers in education*. OECD Publishing, Paris. Retrieved from http://dx.doi.org/10.1787/9789264207585.en

OECD (2016). *PISA 2015 results (Volume I): Excellence and equity in education*. OECD Publishing, Paris. Retrieved from http://dx.doi.org/10.1787/9789264266490-en

Passolunghi, M. C., Caviola, S., De Agostini, R., Perin, C., & Mammarella, I. C. (2016). Mathematics anxiety, working memory, and mathematics performance in secondary-school children. *Frontiers in Psychology, 7*. doi:10.3389/fpsyg.2016.00042

Pintrinch, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801–813.

President's Council of Advisors on Science and Technology. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Retrieved from http://files.eric.ed.gov/fulltext/ED541511.pdf

Royster, P., Gross, J., & Hochbein, C. (2015). Timing is everything: Getting students back on track to college readiness in high school. The High School Journal, 98(3), 208–225. doi:10.1353/hsj.2015.0005

Spielhagen, F. R. (2006). Closing the achievement gap in math: The long-term effects of eighth-grade algebra. *Journal of Advanced Academics, 18*(1), 34–59.

Summit Learning. (2016). *Personalized learning plan*. Retrieved from https://www.summitlearning.org/

Summit Learning. (2017). *The science of summit*. Retrieved from https://cdn.summitlearning.org/assets/marketing/The-Science-of-Summit-by-Summit-Public-Schools_08072017.pdf

Summit Learning. (2018). *Student experience: Year*. Retrieved from https://help.summitlearning.org/hc/en-us/articles/221139887-Student-Experience-Year

Texas Education Agency. (2007). *Progress measures*. Retrieved from http://tea.texas.gov/Student_Testing_and_Accountability/Testing/State_of_Texas_Assessments_of_Academic_Readiness_(STAAR)/Progress_Measures/

Texas Education Agency. (2013). STAAR vertical scale technical report. Retrieved from https://tea.texas.gov/student.assessment/staar/

Texas Education Agency. (2016). *Technical digest 2015-2016*. Retrieved from https://tea.texas.gov/Student_Testing_and_Accountability/Testing/Student_Assessment_Overview/Technical_Digest_2015-2016/

Texas Education Agency. (2017). STAAR performance labels and policy definitions. Retrieved from https://tea.texas.gov/student.assessment/staar/performance-standards/

Texas Education Agency. (2018a). *House bill 22 2018 accountability decisions framework*. Retrieved from https://tea.texas.gov/2018AccountabilityDevelopment/

Texas Education Agency. (2018b). Graduation Information. Retrieved from https://tea.texas.gov/Academics/Graduation_Requirements/

Texas Education Agency. (2018c) Texas School Report Card. Retrieved from https://txschools.org/

Texas Higher Education Coordinating Board. (2016). *State of higher education address*. Retrieved from http://www.thecb.state.tx.us/reports/

U.S. Department of Education. (2001). *No child left behind act* (NCLB). Retrieved from https://www2.ed.gov/nclb/landing.jhtml

U.S. Department of Education. (2015). *Every student succeeds act (ESSA)*. Retrieved from https://www.ed.gov/essa?src=rn

Walkington, C., Sherman, M., & Howell, E. (2014). Personalized learning in algebra. *The Mathematics Teacher*, *108*(4), 272–279. doi:10.5951/mathteacher.108.4.0272

WestEd. (2016). *What does "postsecondary readiness" really mean when there are multiple pathways to success?* Retrieved from https://www.wested.org/resources/what-does-postsecondary-readiness-really-mean-when-there-are-multiple-pathways-to-success/

Wheeler, S. W., & Bray, N. (2017). Effective evaluation of developmental education: A mathematics example. *Journal of Developmental Education*, *41*(1), 10-17.

Whipps-Johnson, J. (2016). *Teachers' awareness of cultural diversity and academic achievement in ninth grade academies and senior high schools* (Order No. 10013448). Available from ProQuest Dissertations & Theses Global.

Wilka, M., Gutiérrez, E., & Price, H. (2017). Raising blended learners® year 1 evaluation report. Retrieved from https://www.raiseyourhandtexas.org/foundation/blended/

Wonnacott, V. (2011). *Teaching mathematics for social justice and its effects on affluent students* (Order No. MR76261). Available from ProQuest Dissertations & Theses Global. (917244277).

Young, J., Gorumek, F., & Hamilton, C. (2018). Technology effectiveness in the mathematics classroom: A systematic review of meta-analytic research. *Journal of Computers in Education, 5*(2), 133–148. doi:10.1007/s40692-018-0104-2

Young, R. B., Hodge, A. A., Edwards, M. E., & Leising, J. J. (2012). Learning mathematics in high school courses beyond mathematics: Combating the need for post-secondary remediation in mathematics. *Career & Technical Education Research*, *37*(1), 21–33. doi:10.5328/cter37.1.21

Yu, R., & Singh, K. (2016). Teacher support, instructional practices, student motivation, and mathematics achievement in high school. *Journal of Educational Research*, *111*(1), 81–94. doi:10.1080/0020671.2016.1204260

Zelkowski, J. (2011). Defining the intensity of high school mathematics: Distinguishing the difference between college-ready and college eligible students. *American Secondary Education*, *39*(2), 27-54.

Zimmerman, B., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, *29*(3), 663–676.

Zumbrunn, S., Tadlock, J., & Roberts, E. D. (2011). Encouraging self-regulated learning in the classroom: A review of the literature. Retrieved from http://wp.vcu.edu/merc/wp-content/uploads/sites/3387/2013/11/Self-Regulated-Learning-2.pdf

APPENDIX A:

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Informed Consent to Participate in Research

You are being asked to participate in the research project described below. Your participation in this study is entirely voluntary and you may refuse to participate, or you may decide to stop your participation at any time. Should you refuse to participate in the study or should you withdraw your consent and stop participation in the study, your decision will involve no penalty or loss of benefits to which you may be otherwise entitled. You are being asked to read the information below carefully and ask questions about anything you don't understand before deciding whether or not to participate.

Title: Examining the Influence of Blended Learning on Post-Secondary Readiness and Academic Achievement in Mathematics: A Personalized Approach To Learning

Principal Investigator: Sondra E Cano, M.Ed
Faculty Sponsor: Sue Brown, Ph.D.

PURPOSE OF THE STUDY
The purpose of this study is to examine the influence of blended learning on post-secondary readiness and academic achievement in mathematics: a personalized approach to learning.

PROCEDURES
Teacher interviews will be conducted during Fall 2018 to gather input into the differences between blended learning and traditional instruction in mathematics. Classroom observations will be conducted using a blended learning observation tool and the data will be analyzed to determine classroom patterns and trends influencing student performance in mathematics.

EXPECTED DURATION
The total anticipated time commitment for interview participation will be one session of 30-45 minutes while classroom observations will be conducted several times throughout the fall semester during academic year 2018-2019.

RISKS OF PARTICIPATION
There are no anticipated risks associated with participation in this project.

BENEFITS TO THE SUBJECT
There is no direct benefit received from your participation in this study, but your participation will help the investigator(s) better understand the influence of participation in the blended learning flex model on student post-secondary readiness in mathematics.

CONFIDENTIALITY OF RECORDS
Every effort will be made to maintain the confidentiality of your study records. The data collected from the study will be used for educational and publication purposes, but you will not be identified by name. For federal audit purposes, the participant's documentation for this research

project will be maintained and safeguarded by Sondra E Cano for a minimum of three years after completion of the study. After that time, the participant's documentation may be destroyed.

FINANCIAL COMPENSATION

There is no financial compensation to be offered for participation in the study.

INVESTIGATOR'S RIGHT TO WITHDRAW PARTICIPANT

The investigator has the right to withdraw you from this study at any time.

CONTACT INFORMATION FOR QUESTIONS OR PROBLEMS

The investigator has offered to answer all of your questions. If you have additional questions during the course of this study about the research or any related problem, you may contact the Principal Investigator, Sondra E Cano, M.Ed, at 281-660-8825 or by email at CanoS2242@uhcl.edu.

SIGNATURES:

Your signature below acknowledges your voluntary participation in this research project. Such participation does not release the investigator(s), institution(s), sponsor(s) or granting agency(ies) from their professional and ethical responsibility to you. By signing the form, you are not waiving any of your legal rights.

The purpose of this study, procedures to be followed, and explanation of risks or benefits have been explained to you. You have been allowed to ask questions and your questions have been answered to your satisfaction. You have been told who to contact if you have additional questions. You have read this consent form and voluntarily agree to participate as a subject in this study. You are free to withdraw your consent at any time by contacting the Principal Investigator or Student Researcher/Faculty Sponsor. You will be given a copy of the consent form you have signed.

Subject's printed name: ______________________________

Signature of Subject: ______________________________

Date: ______________________________

Using language that is understandable and appropriate, I have discussed this project and the items listed above with the subject.

Printed name and title ______________________________

Signature of Person Obtaining Consent: ______________________________

Date: ______________________________

THE UNIVERSITY OF HOUSTON-CLEAR LAKE (UHCL) COMMITTEE FOR PROTECTION OF HUMAN SUBJECTS HAS REVIEWED AND APPROVED THIS PROJECT. ANY QUESTIONS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT MAY BE ADDRESSED TO THE UHCL COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (281-283-3015). ALL RESEARCH PROJECTS THAT ARE CARRIED OUT BY INVESTIGATORS AT UHCL ARE GOVERNED BY REQUIREMENTS OF THE UNIVERSITY AND THE FEDERAL GOVERNMENT. (FEDERALWIDE ASSURANCE # FWA00004068)

APPENDIX B:

INTERVEIW GUIDE

1. What, if any, previous experiences have you had with blended learning? Please tell me about your experience.
2. Please describe to me in detail what you perceive to be the role of the teacher in blended learning on your campus? On what do you base your perceptions?
3. What student benefits have you observed in the blended learning classroom (in comparison with the traditional classroom model)? Please discuss the benefits in detail.
4. How do you perceive that goal setting (mentorship and reflection) will affect student learning? On what do you base your perceptions?
5. How do you perceive that competency-based content progression will affect student achievement in mathematics? On what do you base your perceptions?
6. In what ways has developing students' habits of success influenced student performance in the classroom?
7. Please describe an instance when you felt extreme joy over the effectiveness of blended learning in reaching all learners. Share your experience in as much detail as possible.
8. Please describe an instance when you felt blended learning was a complete waste of time. Share your experience in as much detail as possible.
    a. How were you able to get past this experience?

9. Changing classroom practice and methodology demands a degree of vulnerability. Describe for me the changes you have had to make in order to reach all learners through blended learning.
10. The district is expanding the number of students enrolled in blended learning and implementing on more campuses. If the opposite were true and the district decided to not offer blended learning as a choice for high school students, what would you miss about the model? Describe in detail what you would miss the most.
11. As you look ahead to next year, what specific recommendations do you have for enhancing the program and increasing the effectiveness of the model on student learning? Describe in detail the changes you would make and why.
12. Is there anything you would like to add about your experiences in blended learning that would help explain the differences between blended learning classrooms and traditional classrooms?
13. Participant demographics:
    a. How long have you been teaching?
        i. How many years in a traditional classroom?
        ii. How many years in a blended learning classroom?
    b. In what areas do you hold certifications?
    c. Do you consider yourself male/female?
    d. What race/ethnicity do you identify with?
    e. What is your age?

APPENDIX C:

BLENDED LEARNING CLASSROOM OBSERVATIONAL TOOL

Use this form to collect data while observing in Connect classrooms. Choose the learning structure and then check the box if you see that "evidence" of the action you are looking for occurs at a satisfactory level. Leave the box unchecked if you see a "missed opportunity" for the action you are looking for.

* Required

1. **High School Site** *
Mark only one oval.

- ◯ Site A
- ◯ Site B
- ◯ Site C
- ◯ Site D
- ◯ Site E

2. **Classroom** *
Mark only one oval.

- ◯ BL Algebra I
- ◯ BL Geometry
- ◯ BL Algebra II

3. **Learning Structure** *
Mark only one oval.

- ◯ 1:1 mentor Check-in *Skip to question 4.*
- ◯ math concept unit *Skip to question 14.*
- ◯ student directed learning (SDL) *Skip to question 25.*

Mentor Check-In

Is a 1:1 mentor check-in happening? If so, does it meet the criteria below?

4. **ORDER AND TIMING- the student order and timing of 1:1 check-ins is prioritized based on student data.**

   Mark only one oval.

   - missed opportunity
   - evidence
   - not observed

5. **COACHING ON HABITS- the 1:1 check-in is organized around supporting self-direction strategies and/or motivation, based on the student's data and observed behaviors.**

   Mark only one oval.

   - missed opportunity
   - evidence
   - not observed

6. **POSITIVE RELATIONSHIPS- there is evidence of positive relationships between mentor and student, wherein they seek to know each other as learners and people.**

   Mark only one oval.

   - missed opportunity
   - evidence
   - not observed

7. **SOOTHING STRESS- when a student appears stressed or verbalizes stress, the mentor engages to soothe the stress with an appropriate level of compassion by hearing and validating the stress while not lowering expectations.**

   Mark only one oval.

   - missed opportunity
   - evidence
   - not observed

8. **SELF ASSESSMENT- students are given the opportunity to self-assess their strengths and areas of necessary growth based on their weekly work.**

   Mark only one oval.

   - missed opportunity
   - evidence
   - not observed

9. **STUDENT FACILITATION- students are developing the facilitation skills to listen, co-lead, and then lead 1:1 check-ins with their mentor.**
Mark only one oval.

- ◯ missed opportunity
- ◯ evidence
- ◯ not observed

10. **SETTING LEARNING GOALS- students are setting and being held accountable to measurable, timely, and personalized goals for skills, content knowledge, and habits.**
Mark only one oval.

- ◯ missed opportunity
- ◯ evidence
- ◯ not observed

11. **NEXT STEPS- the student walks away from the 1:1 check-in with clear goals and action steps recorded in the "this week" tab in the platform.**
Mark only one oval.

- ◯ missed opportunity
- ◯ evidence
- ◯ not observed

12. **SET UP FOR SUCCESS- the student leaves the check-in having the resources they need to be action oriented to meet their goals.**
Mark only one oval.

- ◯ missed opportunity
- ◯ evidence
- ◯ not observed

13. **Field Notes**

____

____

____

____

____

Stop filling out this form.

Math Concept Unit

Is a math concept unit being taught? If so, does it meet the criteria below?

14. **COMPELLING LAUNCH- the teacher facilitates an experience during the launch that builds towards a compelling prompt or set of aligned problems that serve as the focus of the students' work time.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

15. **CLEAN LAUNCH- the launch sets students up to begin working on the math task without additional teacher support or intervention, and the launch sets an expectation for students to work at the upper limit of their ZPD.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

16. **DEVELOP THE QUESTION- the teacher develops the question by asking what students notice or wonder, or by asking students to estimate or make a conjecture.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

17. **PRIME STUDENTS' THINKING- 1. teacher previews the lesson's enduring understanding(s) and 2. teacher reminds students of routines, norms, and scaffolds available to support the procedural knowledge needed for them to access the task.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

18. **RIGOROUS DISCOURSE- students engage in rigorous discourse where they draw connections and build off each other's thinking: analyzing, evaluating, applying, and synthesizing ideas.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

19. **ENDURING UNDERSTANDINGS- the teacher highlights the lesson's enduring understandings during the wrap, and makes explicit connections to what has come before and what will be done in the future.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

20. **SELECTING AND SEQUENCING- the teacher has thoughtfully selected and sequenced students' contributions in building to the lesson's enduring understanding.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

21. **CONNECTIONS- the teacher explicitly connects students' contributions in order for students to extend and enrich their understanding.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

22. **MATHEMATICAL COHERENCE- the teacher promotes students' development of a coherent view of mathematics by supporting meaningful connections among procedures, concepts, and (where appropriate) contexts.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

23. **SOLICIT STUDENT THINKING- the teacher solicits student thinking in order to instructionally respond appropriately, e.g. by building on productive beginnings, addressing emerging misunderstandings, etc.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

24. **Field Notes**

Student Directed Learning

is SDL time happening? If so, does it meet the criteria below?

25. **ARTICULATED GOAL- students have an articulated goal for the available time, related to the academic outcomes.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

26. **ARTICULATED PLAN- students have an articulated plan on how to achieve their academic goals during the available time, based on available data (e.g., diagnostic, self-reflection).**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

27. **CONTENT ASSESSMENT READINESS- students can articulate how they have prepared for content assessments and how they have determined they are ready to take them.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

28. **CONTENT ASSESSMENT SECURITY- students take content assessments in an academically secure environment.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

29. **REFLECTION- students can articulate ways in which previous successes and failures have informed their learning process.**

    Mark only one oval.

    - missed opportunity
    - evidence
    - not observed

30. **MAXIMIZING LEARNING TIME- students work with urgency for the available time and take thoughtful breaks, so that instructional time is maximized.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

31. **ON-DEMAND HELP- students have structured ways to get on-demand help when they're stuck.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

32. **PEER SUPPORT- students have authentic opportunities to support each other's learning.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

33. **PARTIAL GROUP INTERVENTIONS- students participate in teacher facilitated, strategic, prioritized partial group interventions when appropriate.**

Mark only one oval.

- missed opportunity
- evidence
- not observed

34. **ONE-TO-ONES- students have one-to-one check ins when needed that help them build**

35. **Field Notes**

Powered by
Google Forms