January 2016

The Association Between Achievement On Kentucky's College Readiness Assessments And The Intervention Delivery Method Provided To Underprepared Twelfth Grade Mathematics Students

Barbara Darlene Spurlock
Eastern Kentucky University

THE ASSOCIATION BETWEEN ACHIEVEMENT ON KENTUCKY'S COLLEGE READINESS ASSESSMENTS AND THE INTERVENTION DELIVERY METHOD PROVIDED TO UNDERPREPARED TWELFTH GRADE MATHEMATICS STUDENTS

By

Barbara Darlene Spurlock

Dissertation Approved:

Charles Hausman

Dr. Charles Hausman, Advisory Committee Chair

Dr. James Bliss, Advisory Committee

Dr. Robert Thomas, Advisory Committee

Dr. Faye Deters, Advisory Committee

Dr. Jerry Pogatshnik, Dean, Graduate Education & Research

STATEMENT OF PERMISSION TO USE

In presenting this dissertation in partial fulfillment of the requirements for a Doctorate in Education degree at Eastern Kentucky University, I agree that the library shall make it available to borrowers under rules of the library. Brief quotations from this dissertation are allowable without special permission, provided accurate acknowledgment of the source is made.

Permission for extensive quotation from or reproduction of this dissertation may be granted by my major professor, Dr. Charles Hausman, or in his absence, by the Head of Interlibrary Services when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this dissertation for financial gain shall not be allowed without my written permission.

Signature Barbara Darlene Spurlock

Date November 29, 2016

THE ASSOCIATION BETWEEN ACHIEVEMENT ON KENTUCKY'S COLLEGE READINESS ASSESSMENTS AND THE INTERVENTION DELIVERY METHODS PROVIDED TO UNDERPREPARED TWELFTH GRADE MATHEMATICS STUDENTS

By

BARBARA DARLENE SPURLOCK

Master of Education
University of the Cumberlands
Williamsburg, Kentucky
2013

Master of Education
Eastern Kentucky University
Richmond, Kentucky
1990

Bachelor of Education
Eastern Kentucky University
Richmond, Kentucky
1985

Submitted to the Faculty of the Graduate School
Eastern Kentucky University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
December 2016

DEDICATION

This dissertation is dedicated to all future high school graduates who depend on us for high quality college and career preparation opportunities.

This is also dedicated to my children and grandchildren as inspiration to make the world a better place through love, service, and the education of our youth.

ACKNOWLEDGEMENTS

I am grateful to my dissertation chair and advisor, Dr. Charles Hausman for his expertise, compassion, and academic guidance instrumental to this accomplishment. I would also like to express my deepest appreciation and gratitude to my professional and personal mentor, Dr. Robert Thomas, for inspiring me to find my academic and professional niche. Thanks also to my friend and committee member, Dr. Faye Deters for her confidence in me and for being an invaluable member of my dissertation advisory committee. I am also grateful for the kindness, guidance and clarity provided by Dr. James Bliss.

My success has been enhanced by a long list of educational leaders who had confidence and faith in my potential to become a leader in education. I would like to thank, my father, Ronald Spurlock, for his unique advice for staying focused to finish all of my educational pursuits quickly and successfully. I would like to remember my late Grandmother, Adir Couch Elam, for being the first woman in our family to go to college and inspire a long line of family educators and leaders. Her unconditional love and guidance encouraged me to grow up to be strong and service minded. Thanks to my uncle, William Elam, who has always been a huge cheerleader in my court. Along my professional journey, the following educational leaders recognized my passion and provided me opportunities for tremendous professional growth and career advancement: Paige Stevens, Susan Allred, and Karen Dodd. Thanks also to my incredibly supportive friends and classmates, Dr. Tara Isaacs, Dr. Lizette Rogers, and Christi Wright, who made this journey more enjoyable. My furry faithful companion, Dane, was warm emotional support with his puppy love, patience, and long naps next to me while I wrote.

A deep heartfelt recognition goes to Thaveechart "Ta" Cline for his incredible support, kindness, tender loving care, and shared excitement for the completion of this journey with me. Above all, thanks be to our magnificent God for all of His blessings. Through God all things are truly possible!

ABSTRACT

The purpose of this retrospective quantitative study was to determine if there was an association between achievement on Kentucky's college readiness assessments and intervention delivery methods: (1) face-to-face tutoring only; (2) online/digital tutoring only; or (3) blended learning tutoring provided to underprepared twelfth grade mathematics students. Data used for this study were provided voluntarily from four Kentucky districts representing six high schools. Descriptive statistics and Chi Square statistical significance research methods were used to determine the association between assessments and intervention instructional delivery models. Bivariate correlations were used to determine a weak correlation between Kentucky's three college readiness assessments (ACT, COMPASS, and KYOTE). It was found that blended learning tutoring was associated with the greatest achievement on each of the three Kentucky college readiness assessments, greatest mean scale scores, and overall college readiness achievement statuses when compared to face-to-face tutoring and online/digital tutoring intervention instruction.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

American College Test……………………………………………………..……ACT

Adaptive, Personalized & Individualized Learning………………………………..APIL

College and/or Career Ready………………………………………………………CCR

College Ready…………………………………………………………………….CR

Council for Postsecondary Education……………………………..………………..CPE

English Language Limited………………………………………………………….ELL

Elementary and Secondary Education Act………………………………………..ESEA

Every Student Succeeds Act…………………………………………..……….ESSA

Face-to-Face Instruction……………………………………….........................F2F

Free/Reduced Priced Lunch……………………………………...…………..FRPL

House Bill…………………………………………………………..……..…………HB

Kentucky Administrative Regulation………………………………..……….…….KAR

Kentucky Department of Education………………………………..………….……KDE

Kentucky Revised Statute…………………………………………..…………….…KRS

Kentucky Online Testing………………………………………………………..KYOTE

Legislative Research Commission……………………………………………….LRC

No Child Left Behind………………………………………………………..……NCLB

Response to Intervention……………………………..………………..………..RtI

School Based Decision Making………………………..…………………………SBDM

Socioeconomic Status………………………………………………………………SES

CHAPTER 1: INTRODUCTION

This retrospective quantitative study will determine the association between achievement on Kentucky's college readiness assessments: American College Test (ACT); Computer Placement Assessment (COMPASS), and Kentucky Online Testing Examination (KYOTE); and the intervention delivery methods provided to underprepared twelfth grade mathematics students. Data used for this analysis were voluntarily provided by four districts representing six high schools and 795 underprepared students. College readiness benchmark scores data from the eleventh grade statewide ACT administration were used to classify students as underprepared in mathematics. For the purposes of this study, students in the class of 2015 who did not meet the Kentucky Council for Postsecondary Education (CPE) college ready benchmark score of 19 on the mathematics subtest were classified as underprepared and not college ready.

This study involved descriptive, bivariate correlational, and Chi Square statistical significance research methods. Descriptive statistics were used to determine the mean scale scores for students who did not meet CPE benchmark on the eleventh grade ACT statewide administration in mathematics grouped by district. Descriptive statistics were used once again to determine the mean scale super scores for students who took the ACT, COMPASS and KYOTE in the twelfth grade. Chi Square Descriptive Crosstabs and Fisher's Exact Test were used to explore the association between college readiness benchmark achievement statuses for each assessment by the intervention delivery method. Also of importance to this study is the bivariate correlation between the assessments used in Kentucky to measure college readiness in mathematics.

Findings from this study intend to provide evidence for guiding leadership practices and educational policies for twelfth grade mathematics interventions leading to college readiness. The three state identified intervention delivery methods are face-to-face, digital learning, and blended learning tutoring. The purpose of this dissertation was to provide a better understanding of Kentucky's college readiness system, college readiness measures and indicators, intervention delivery methods, and accelerated learning to support underprepared students in achieving college readiness status effectively and efficiently prior to graduation.

College readiness for K-12 graduates in high school was measured by the achievement of benchmark scores set by the CPE and the Kentucky Department of Education (KDE) consisting of an 18 in English, 19 in mathematics and 20 in reading on the ACT. Of the twelfth grade students statewide 44.1% did not meet the CPE college readiness benchmark score of 18 for English, 56.5% did not meet the CPE benchmark of 19 for mathematics, and 52.9% did not meet the CPE benchmark of 20 for reading on the eleventh grade statewide ACT administration. Students not meeting the required CPE benchmarks are labeled as underprepared. Because the greatest number of students did not meet mathematics ACT benchmarks compared to English and reading, mathematics was chosen as the area of focus for this study.

Based on No Child Left Behind (NCLB), Kentucky's accountability model, Kentucky legislation KRS 158. 6459 and resulting regulation 704 KAR 3:305 all underprepared students are mandated to be provided a transitional course or accelerated learning intervention tutoring. Additionally, provided must be opportunities to retake college readiness benchmark assessments such as ACT, COMPASS, and KYOTE. All of the aforementioned requirements must be provided prior to graduation in an eleventh hour rally to achieve college readiness status. As of 2014, the Kentucky Department of Education required schools to track every underprepared twelfth grade student and transitional course or intervention in the statewide student management system, Infinite Campus. These transitional courses and interventions fall into three instructional delivery methods: (1) face-to-face tutoring, (2) online tutoring, or (3) blended learning tutoring.

Background of the Study

A report from the Center on Education and Workforce Development released in 2010 finds that 63 percent of the 46.8 million job openings created by 2018 will require some type of postsecondary degree (Carnevale, Smith, & Strohl, 2010, Amos, 2010). Now more than ever, schools need to prepare secondary students for this rapidly changing workforce requirement. College readiness is no longer a recommendation but a necessity. One prerequisite benchmark to enrolling in many required credit bearing postsecondary education courses in Kentucky is that students meet the Council for Postsecondary Education requisite ACT benchmark scores of 18 in English, 19 in mathematics and 20 in reading prior to high school graduation. Other college readiness assessments exist as additional options for college readiness achievement such as ACT COMPASS and KYOTE. For the purposes of this study and in actual practice in Kentucky, the ACT will be the instrument used for measuring college readiness achievement. In Kentucky, 44.1% of eleventh grade students did not meet the ACT CPE college readiness benchmark for English; 56.5% did not meet the CPE benchmark in mathematics; and 52.9% did not meet the CPE benchmark in reading on the eleventh grade statewide ACT administration (Kentucky Department of Education [KDE] School

Report Card, 2016). Because 56.5% of Kentucky's mathematics students entered their twelfth grade year underprepared, academic interventions and transitional course are critical to address the knowledge and skill gaps. Intervention instruction delivery methods need to be research-based, aligned, efficient, and individualized, in order to heighten the value of the final year of high school. College readiness can be achieved for most students in this final rally if all efforts are aligned, efficient and effective.

Problem Statement

Because 56.5% of the statewide class of 2015 did not meet the CPE benchmark of 19 for mathematics on the eleventh grade statewide ACT administration, mitigations were urgent for Kentucky's underprepared twelfth grade students (KDE School Report Card, 2016). In the four participating districts, the average percentage of students not meeting CPE benchmark comes in slightly higher than the state average at 63.3%. Even though these students should have already completed their required three mathematics core courses by the end of their eleventh grade year, knowledge and skill gaps still exist evidenced by the quantity of students not meeting the ACT benchmark on the statewide administration and in the participating districts of this study (704 KAR 3:305, 2016).

Significance of the Study

Based on data from six Kentucky high schools, college readiness rates prior to graduation can be improved both individually and schoolwide. After having received most of their core course content by their twelfth grade year, 63.3% of the students in the participating districts did not meet college readiness benchmark scores. These shortfalls require high schools to provide transitional courses and interventions to students prior to their graduation. Kentucky uses its college readiness assessments and interventions to increase the significance of the twelfth grade year for underprepared students. Through a cycle of assessment and intervention tutoring, underprepared students can possibly achieve college readiness preparing them for credit bearing college courses during their twelfth grade year (Zinth & Millard, 2015). This intervention tutoring requires schools to allocate additional (already limited) resources. Given that this problem should have been addressed much earlier than twelfth grade, it can be considered a moral imperative to surround present underprepared students with individualized and intense interventions in the limited amount of time of the final year of high school.

The findings in this study intend to provide evidence that may influence practices of school administrators and teachers relative to selecting and implementing effective and efficient intervention tutoring delivery methods. More importantly, the findings of this study may influence school, district, and state policy makers to design and execute policy for effectively and efficiently leveraging resources intended to increase the success of interventions.

Purpose of the Research

The purpose of this retrospective quantitative study is to determine the association between achievement on Kentucky's three college ready assessment of the underprepared students in the Class of 2015 after completion of required transitional courses or intervention tutoring by delivery method: (1) face-to-face tutoring; (2) digital learning tutoring; or (3) blended learning tutoring.

Currently, Kentucky schools are provided transitional course curriculum for English Language Arts and mathematics, but ultimately are given freedom to choose curriculum and delivery details of transitional courses and interventions for their underprepared twelfth grade students. Per Kentucky Statute 13 KAR 2:020, transitional courses or interventions are to be monitored to address remediation needs. Transitional courses can be monitored through course codes, and Extended School Services interventions can both be monitored within Infinite Campus. Not all interventions being provided to students were caught in the Infinite Campus net. Now, with the Intervention Tab, intervention data for third year focus school students and twelfth grade students not achieving college readiness are being collected and reviewed by stakeholders.

A KDE study published in 2014 by the Institute of Education Sciences (IES) reported that statewide 60% of Kentucky high schools did not offer transitional courses (Mokher, 2014). The study did not address interventions provided to the twelfth grade students, only transitional course enrollment. Starting in 2014, the Intervention Tab was developed with the intent to monitor intervention details using Kentucky's student management system, Infinite Campus (Mokher, 2014). Data extract reports from the Intervention Tab provided a glimpse into how Kentucky high schools leveraged all available resources to boost underprepared twelfth grade students to college readiness status. The intervention tab was expected to track the resources and interventions provided to all Kentucky underprepared twelfth grade students. Combining both course codes for transitional courses and Intervention Tab data it is expected to provide a comprehensive depiction of how Kentucky high schools were delivering remediation services to underprepared twelfth grade students.

Thirteen data elements were monitored regarding interventions through the custom Intervention Tab including an indication of intervention delivery methods consisting of: (1) face-to-face tutoring; (2) digital learning tutoring; or (3) blended learning tutoring (being the focus of this study). Analyzing the association in college readiness achievement after student participation in the three intervention delivery models should provide educational leaders a basis on which to do further research based on these findings to select highly effective intervention tutoring. Decisions should then be better based on student needs to more efficiently achieve higher college readiness outcomes.

Since the introduction of private market technology-based instructional tools in Kentucky, schools and school districts are selecting these technology options for their students as interventions. A review of research literature on the effectiveness of online/digital learning and blended learning is lean due to small sample sizes and widely varying variables impacting studies K-12 students and their learning environments (Means, et. al., 2010). Effectiveness of online/digital learning and blended learning had mixed results while the same types of studies showed positive results for college adults, both undergraduates and graduate students (Means, Toyama, Murphy, Bakia, & Jones, 2010). No research was found on the effectiveness of interventions for students transitioning out of the K-12 environment in preparation for the postsecondary environment.

Unique to Kentucky's intervention guidance documents from KDE, 76 online or computer assisted vendors used in Kentucky schools are listed in KDE's intervention materials vendor list (Pieper, 2014). How these online and computer assisted intervention systems compare to the traditional face-to-face tutoring or even blended learning tutoring has not been analyzed. This study hopes to uncover the possible association between achievement on each of Kentucky's college readiness assessments and each intervention delivery method.

Research Questions

Q1: What is the association between achievement on the ACT college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

Q2: What is the association between achievement on the COMPASS college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

Q3: What is the association between achievement on the KYOTE college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

Q4: What is the association between achievement on any of the college readiness assessments consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

Theoretical Framework

Kentucky legislation and regulation describes the type of intervention to be provided be an accelerated learning intervention (704 KAR 3:305; KRS 158.6459, 2016). An accelerated learning intervention is founded on the accelerated learning theory work of Dr. Georgi Lozanov and Dr. Howard Gardner (Bonanno, 2000). Accelerated learning is a method by which students with knowledge and skill gaps are provided targeted instruction only on the areas of deficiencies. By building on previous knowledge and streamlining instruction, the student is not subjected to cognitive overload that occurs when a student is subjected to repeat an entire course instead of only content needed. If too much content exceeding the student's cognitive capacity is presented, the student may not master what is needed (Mayer & Moreno, 2003, Accelerated Learning, 2011).

Additionally, accelerated learning is an adult learning theory which makes it appropriate for twelfth grade students who are adults or on the cusp of adulthood. Accelerated learning can further be described as using the individualization as described above with results being achievement of learning in a shorter amount of time or a greater amount of learning in the same amount of time (Patchan, Schunn, Sieg, & McLaughlin, 2016). Accelerated learning can occur in any of the three delivery methods.

Interventions ideally should involve some type of one-to-one tutoring to individualize the instruction to meet specific student knowledge and skill gaps as described by the accelerated learning theory. Benjamin Bloom conducted significant tutoring research in 1984, finding that students who received one-to-one human tutoring yielded an impact of two standard deviations above those student receiving traditional classroom instruction. This equals a student achievement increase from 50% to 98% (Bloom, 1984).

Prior to the merger of technology into education, knowledge dissemination was sluggish. Rapidly improving communication technologies and digital instructional design has increased the speed and rigor of knowledge dissemination exponentially to the point knowledge has acquired a half-life (Siemens, 2005). Knowledge can be shared via multiple instructional communication technologies. At the foundation of providing intervention instruction lies the accelerated learning theory that addresses the specific knowledge and skill gaps while building on the existing knowledge and skills of the learner.

The issue with increased speed and rigor of knowledge being presented in multiple modes of media, is that it can lead to cognitive overload for the already challenged underprepared students. At the foundation of cognitive overload lies the Cognitive Load Theory when too much knowledge is presented to students with few connections, students struggle to commit the knowledge and processes to long term memory. This means that learning must be individualized, adaptive, and personalized (Blayney, Kalyuga, & Sweller, 2015).

With the increase of technological capacity, more and more online tutoring systems are being developed and the efficiency is increasing with the advancement of research and computer processor speeds (Dolenc, Aberšek, & Aberšek, 2015). Many online tutoring systems and online intelligent tutoring systems can mimic the human one-to-one tutoring in that online tutoring systems can diagnose, set learning targets, design an instructional path, formatively assess student progress, update the learning path and then summatively assess mastery while communicating progress to both student and teacher. (Serçe, Alpaslan, & Jain, 2008, Wang, Han, & Yang, 2015).

Summary

Over half of Kentucky's rising class of 2015, entered their final year of high school underprepared with mathematics ACT scores short of established college readiness benchmarks. High schools have only one school year to boost these students to college readiness status. National and state policy was established setting benchmarks and mitigations that require high schools to provide accelerated learning interventions to every student who did not meet college readiness benchmarks. Three delivery methods are provided as options for these accelerated learning interventions: (1) face-to-face tutoring; (2) digital learning tutoring; and (3) blended learning tutoring. Accelerated learning, recommended by state policy, has typically been an adult learning theory that is being applied to Kentucky's twelfth grade underprepared students. Accelerated learning can be implemented in any of the three delivery methods.

The purpose of this study was to determine if there was an association between achievement on Kentucky's college readiness assessments and each of the accelerated intervention tutoring delivery methods: (1) face-to-face only; (2) digital learning tutoring only; or (3) blended learning tutoring. The findings for this study intend to positively impact an increase in college readiness achievement prior to graduation; guide school administrators and teachers to select and provide effective interventions; and influence district and school policy makers to design and execute policies to efficiently leverage resources for successful interventions.

This dissertation is divided into five chapters. Chapter One describes the problem, issues and purpose of the study. Chapter Two provides a synthesis of related research and literature related to this study. Also, Chapter Two provides clarification on the conceptual framework, theoretical framework, constructs and the relationships that exist between them. Chapter Three discusses the research methodology, sampling technique, data collection and data analyses procedures. Chapter Four presents the analyses and related findings. Chapter Five summarizes the results, implications, recommendations for professional practice and further research.

Operational Definitions

Accelerated Learning Intervention: instruction provided to address specific student learning goals in order for the student to receive what is needed at individual skill and knowledge levels. This is not to be confused with accelerated learning for gifted students which provided higher levels of learning at an advanced pace (Hamon, 2012).

Blended Learning Tutoring System: Individual student receives both face-to-face instruction and digital learning in any of the blended learning models.

CPE College Readiness Benchmark: CPE established a 19 scale score as college readiness for mathematics on ACT, 36 on COMPASS, and 22 on KYOTE.

College Readiness Achievement: For this study, to be considered college ready in mathematics nationally, students must meet the CPE college readiness benchmarks on American College Test, COMPASS or KYOTE mathematics assessment.

College Readiness Achievement Status: For this study, the two descriptors involve either met or did not meet CPE benchmarks on mathematics assessments only.

Digital Learning: General term used to describe content, instruction, assessment, or communication using digital devices over a network connected to the Internet.

Face-to-Face Tutoring System: Individual student receives only face-to-face instruction from a human tutor within the confines and time frame of a physical school building school day with additional intervention or enrichment.

Online/Digital Learning Tutoring System: Individual student receives tutoring via technology such as online or digital device delivered content, practice, assessment and instruction. These tutoring systems can be either drill and practice in nature, adaptive, interactive or contain intelligent tutoring capacity. For the purpose of this study, digital learning will encompass computer-assisted intruction, computer-based instruction, multimedia, hypermedia, intelligent tutoring systems, and online courses.

Underprepared Twelfth Grade Students: Twelfth grade students who did not achieve an ACT score sufficient to achieve college ready status in mathematics at the onset of twelfth grade school year by Council of Postsecondary Education.

Scale Super Score: The highest score attained from any one of multiple retakes on any of Kentucky’s college readiness assessments.

CHAPTER 2: LITERATURE REVIEW

Introduction

This review of related literature will discuss refereed research on college readiness, digital learning, and the role of intervention in the achievement of increased college readiness for our high school graduates. Educational legislation and federal regulations have historically attempted to increase college readiness with a few bumps in the road. The essence of continuous improvement and rapidly increasing technologies have nurtured repealed, revised and newly enacted policies for the increase in college readiness. Legislators, state education department leaders, district and school level administrators are working in concert to discover model professional practices, policies, and theories. All efforts will increase access, equity, and quality of our K-12 students' college and career preparation whether it be face-to-face instruction, online/digital instruction or a blended learning.

The epitome of employment for our future graduates now requires advanced knowledge and skills acquired from adequate postsecondary preparation (Autor & Katz, 2010). As more employers are resorting to automation, robots, network and desktop computing to reduce headcount, only highly-skilled, postsecondary educated and technologically savvy employees are hired to work in this increasing technology dependent work environment (Friedman & Mandelbaum, 2011). By the year 2020, it is expected that 65% of all jobs will require postsecondary education, specifically 11% will require master's degree, 24% will require a bachelor's degree, 12% will require an associate's degree, and 18% will require some type of postsecondary training or an industry certificate (National Forum on Education Statistics, 2015).

Many Kentucky colleges have holistic score admissions which mean there are no specific minimum score requirements. However, the minimum CPE mathematics benchmark of 19 places students in the bottom 25% of students enrolled in 10 of Kentucky's largest 13 colleges ("Compare ACT Scores for Admission to Kentucky Colleges and Universities," 2016). Some Kentucky high school athletes with marginal ACT score considered for college scholarships have also come up short of the required composite ACT score of 18. For next year, NAIA has lowered the required ACT composite score to a 16 (NAIA, 2016).

The increasing technical nature of today's jobs means that our students need to acquire a post-secondary education degree. Our students need advanced mathematical knowledge and skills as well as experience interacting with online platforms and tools to increase student aptitude and attitude toward technology (Gecer & Dag, 2012). Additionally, high school graduates need to be aware of college enrollment requirements that exceed Kentucky's college readiness benchmarks. Now more than ever our high school graduates need to be ready for college to persist on to graduation with sufficient career knowledge and skills.

State of College Readiness

There is a chasm of disconnect between the transition process from high school mathematics to college mathematics. The principal cause of this chasm is the lack of common vision and common standards for our high schools and colleges. (Madison, 2001). Also remaining is a great deal of haziness regarding the definition of college readiness. College/Career Ready status is the goal of our current twelfth grade students. Varying viewpoints say mathematics college readiness is measured by grade point average, high school courses are completed, performance in college entry-level courses and by the benchmarks on math assessments.

> A summary of the viewpoints is succinctly mirrored by Conley's (2007) statement "college readiness can be defined operationally as the level of preparation a student needs to enroll and succeed – without remediation – in a credit-bearing general education course at a postsecondary institution that offers a baccalaureate degree or transfer to a baccalaureate program" (p. 5).

Conley (2007) and Cain (2011) further defines mathematics college readiness as the capacity of a student to be successful in a college credit bearing course without the need for remedial or developmental mathematics courses. Brown and Conley (2007) in another study found that high schools who previously used other measures to determine college readiness such as state tests found that these assessments did not sufficiently measure higher order thinking skills, thus meeting benchmark on a state test did not mean the students were college ready.

Success is achieved when the student completes the credit bearing entry level course with proficiency such that the student can enroll in the next level class in the course sequence (Educational Policy Improvement Center [EPIC], 2007). Upon admission to any state or public supported postsecondary institution, the student must have met or exceeded state established system-wide learning outcomes and college readiness sub-scores on the English, mathematics or reading American College Test exam unless the student has taken any of the other CPE college readiness assessments also used by postsecondary institutions for course placement such as COMPASS or KYOTE assessments (13 KAR 2:020, n.d.). At the state level, college readiness activities in Kentucky include: (1) definition of college readiness; (2) required college-preparatory curriculum for high school diploma; (3) aligned high school assessments to postsecondary system; and (4) state high school assessment results are reliable for postsecondary admissions, placements, and scholarship decisions (National Center for Education Statistics [NCES], n.d., State Education Reforms, 2013).

National and State Legislative History

The history of national education law has shown progress over the past 50 years with higher than ever high school graduation rates and more students going to college (Every Student Succeeds Act, 2015). In 1965, The Elementary and Secondary Education Act (ESEA) was established as the nation's national education law providing an equal opportunity public education system for every student (Every Student Succeeds Act, 2015). Under the umbrella of ESEA, the No Child Left Behind Act was enacted in 2002, representing a actionable national push for increased achievement for disadvantaged students. All student demographic groups were examined closely for progress as well as indicators for additional student academic support. Actions for increased student achievement, accountability and support fell upon each state's government (No Child Left Behind - ED.gov, 2002). Fast forward 50 years later to 2015, after NCLB requirements became too difficult to carry forward, the Obama administration created a better law called the Every Student Succeeds Act (ESSA) to focus on preparing all students to succeed in college and careers (Every Student Succeeds Act, 2015). Educational stakeholders, business leaders and political leaders with interest in America's future called for national reform after American dropped from leading the world in college graduation rates to 12th place (College- and Career-Ready Standards, n.d.). These same stakeholders and leaders have charged America's educational systems with helping students succeed in our highly competitive, complex and globally connected future workplaces.

Mathematics college readiness weighed in at 43.5% of Kentucky students scoring a 19 or higher compared to the national college readiness rate of 42% scoring a 22 or higher (KDE School Report Card, 2016, ACT, 2015). The differing benchmarks are the result of two organizations establishing two benchmarks indicating success. The American College Testing (ACT) organization measures college readiness nationally with a score of 22 or higher. A 22 by ACT means that students have a 50% chance or higher of achieving a B in credit-bearing college level courses and a 75% chance of achieving a C or better (The Condition of College & Career Readiness 2015 National, 2015). In the fall of 2012, Kentucky's Council for Post-Secondary Education established an ACT benchmark score of 19 which labels the student as college ready only in the context of not being required to take noncredit bearing developmental math courses upon college entrance (Cain, 2012).

United States policy makers, educational leaders, and business leaders are in agreement that our students need to graduate from high school with higher achievement rates to persist in post-secondary efforts (Callan, Finney, Kirst, Usdan, & Venezia, 2006). The No Child Left Behind Act of 2001 was an act created to close achievement gaps while holding schools and districts accountable (NCLB 2001, 2002). In 2010, President Obama summoned the reform of the No Child Left Behind Act of 2001. The Reauthorization of the Elementary and Secondary Education Act (ESEA) called for all students to graduate from high school college and/or career ready by 2020 (U.S.

Department of Education, 2010). Facilitating this goal means that new state assessments aligning with college and/or career ready standards need to be developed (U.S. Department of Education, 2010). Moving forward to present day 2016, the bi-partisan reauthorization of ESEA is now termed as the Every Student Succeeds Act (ESSA). ESSA has migrated away from the focus on measuring student learning using aligned assessments. The ESSA legal literature has removed the federal prescriptive “college and career readiness” terminology in attempts to encourage schools and districts to provide high quality education with high academic standards. Instead of inundating students with high quantity, low quality traditional assessments, schools are to now focus on improvement planning, so students graduate high school ready for college or careers (Plunkett, 2016). This planning will include the identification of underprepared students and the implementation of plans for improving the school-wide student learning system to meet the needs of the underprepared students (Plunkett, 2016).

Many states have addressed the need for higher achievement and college readiness status with K-12 student achievement and support policies, standards-based reforms, and state assessment with accountability redesigns (Callan et al., 2006). Kentucky was one of those states that launched higher standards and guidance for increasing the college readiness achievement for all students. These increasing college going rates call for increasing student support efforts that result in college readiness for every student graduating from high school from each and every state (Callan et al., 2006).

When the General Assembly passed Senate Bill 1in 2009, that was a momentous step toward improving the educational standards and success criteria for students in Kentucky's public schools by establishing rigorous state policies on college readiness. A vital piece to SB1 uses the ACT assessment to measure college readiness in English, mathematics, and reading. Stating through KRS 158.6459 that any student in grade eight or grade eleven not meeting the CPE benchmarks for college readiness will be provided transitional courses or interventions for accelerated learning solidified the intent of SB1 (Kentucky Council on Postsecondary Education, 2015).

Before graduation, twelfth grade students must achieve benchmarks established by Kentucky's Council for Post-Secondary Education consisting of a 19 on the ACT, 36 on COMPASS or 22 on the KYOTE assessment (Kentucky Council on Postsecondary Education, 2015). If the college readiness benchmark has not been met by the students' twelfth grade year, Kentucky Revised Statute 158 and 704 Kentucky Administrative Regulation 3:305 dictate that these students must be enrolled in an intervention or transition course using accelerated learning to prepare these students for additional opportunities to take college readiness assessments.

In 2011, Kentucky Department of Education and the Council for Postsecondary Education (CPE) collaborated to identify and implement an improvement process to reduce college remediation rates and increase graduation rates. The component of this unified strategy directly related to this study is an accountability criterion for high school students to achieve college readiness in English, math and reading on the ACT (ACT, 2012). If the student does not meet the benchmark, then legislation requires students be enrolled in the appropriate intervention course until benchmark is achieved. KDE and CPE further collaborated to increase curriculum standards in Kentucky by using the recommendations from the mathematics and English content alignment groups as well as the American Diploma Project Network to revise and improve instructional content students were provided to achieve college and career readiness (Noland, 2007).

Current Kentucky Legislation, Regulations, and Policies

To increase the quantity of students who graduate college ready in Kentucky, the Kentucky Legislature collaborated with the Kentucky Department of Education and the Council on Postsecondary Education to improve the state's assessment and accountability system (Mokher, 2014). Per KRS 158.6459 and 704 KAR 3:305, students not meeting college readiness benchmarks on the ACT must participate in an accelerated learning intervention or transitional course then be given the opportunity to retake any of the college readiness assessments in attempts of achieving college readiness status prior to graduation (704 KAR 3:305, 2016; KRS 158.6459, 2016). An intervention is a type of educational instruction, practice, program, curriculum or strategy intended to address specific learning needs (Patterson, 2016). In Kentucky, one type of intervention for a twelfth grader is called a transitional course (Patterson, 2016). The content in a transitional course may come from the Kentucky Department of Education, a cooperating university, or be locally designed. The intervention tutoring process involves the student entering the intervention, taking a diagnostic pre-test which can be the KYOTE or pre-test built into any of the online tutoring systems. The teacher, online tutoring system, or both develops instructional targets, delivers instruction, formatively and summatively assesses learning, and then allows the student to retake any of the college readiness assessments. If the student meets the college readiness benchmark, then the student exits the intervention. If the student does not meet the benchmark, the process is repeated until the student meets benchmark or reaches the maximum number of assessment attempts (Patterson, 2016).

Kentucky legislation and regulation designates that interventions be provided using accelerated learning (704 KAR 3:305, 2016; KRS 158.6459, 2016). Interventions ideally should involve some one-to-one tutoring to individualize the instruction to meet specific student knowledge and skill gaps as described by the accelerated learning theory (Bloom, 1984, Patterson, 2016). Significant tutoring research was conducted by Benjamin Bloom in 1984. He concluded in his research that students who received one-to-one human tutoring yielded an impact of two standard deviations above those student receiving traditional classroom instruction. This equals a student achievement increase from 50% to 98% (Bloom, 1984).

Kentucky College Readiness Assessments and Indicators

States have historically devised systems of standards and assessments to measure attainment of college readiness standards. The ACT and the SAT are widely used in many states as a measure of college readiness, accountability, and post-secondary course placement purposes. Kentucky falls into the category that uses the ACT as the initial college readiness and course placement indicators in the content areas of English, mathematics, and reading. (Brown & Conley, 2007). During the spring of the eleventh grade year, all Kentucky students are given a statewide administration of the ACT for both accountability and college readiness measures (Hurst, 2010). Collaborating with the Kentucky Department of Education, the Council on Postsecondary Education established college readiness indicators for ACT, SAT, COMPASS, and KYOTE college readiness and placement exams (Cain, 2012). Based on the Kentucky Postsecondary Education

Improvement Act of 1997, CPE directs change and improvement in Kentucky's postsecondary education system (Council on Postsecondary Education, 2012). Beginning in 2012, both secondary and postsecondary institutions will use the established indicators or benchmark scores for twelfth grade students' achievement of college readiness status and admission into public postsecondary institution credit bearing courses with no prerequisite developmental, supplemental or transitional course work (Cain, 2012). These minimum benchmark scores only admit students to general college mathematics credit bearing courses. Varying higher scores are required to be admitted into more specialized mathematics courses such as college algebra and program specific mathematics courses of greater difficulty.

ACT

The ACT is the main college readiness assessment used by both Kentucky high schools to measure college readiness and Kentucky colleges for course placement. It is offered six times per year besides the statewide administrations for eleventh grade students. (ACT "Getting Ready," 2016). The eleventh grade administration is free to all Kentucky students. One additional free administration is provided during the twelfth grade year to any student who did not achieve CPE benchmark on the eleventh grade administration. For students who desire to take the ACT again after the first initial free retake, the cost can be steep for additional retakes (ACT "Getting Ready," 2016). If students do not meet college readiness on the first or second administration, it is likely that they will not pay for an additional administration.

The ACT consists of four subtests: English, mathematics, reading and science. Writing is also assessed with an additional writing test. Students are assessed on reasoning, problem solving, analysis, and the application of competences above (KDE, 2015). Score ranges for English, mathematics, reading and science are from 1-36 with 36 being the highest score possible on each subtest. The mathematics subtest consists of 60 multiple-choice questions measuring content knowledge and skills in pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry (ACT, 2010b).

The ACT is a standardized test for high school achievement, college admissions, and college course placement. Many universities in Kentucky use this test to place incoming students in the appropriate college math class for success. While ACT established a 22 math score as the national benchmark, the Council on Postsecondary Education (CPE) established a 19 as the Kentucky benchmark (ACT, 2012). The maximum score possible is a 36.

In February 2013, the ACT Research and Policy Information Brief on ACT's college readiness benchmarks, these scores were referred to as minimum requirement because a student who meets these benchmarks is said to have a 50% probability of achieving a "B" or higher and a 75% chance of achieving a "C" or higher in credit-bearing college mathematics courses (Mattern & Lacina, 2015). There is no secret to success, high quality instruction and a rigorous course progression with early student monitoring and intervention supports is all it takes to meet this minimum requirement to be deemed college/career ready. If a student fails to meet the benchmark in math on the ACT, then the student is offered two attempts on the COMPASS math test and two attempts per term on KYOTE tests (Patterson, 2016). Table 2.1 contains benchmark scores set by CPE for each of the college readiness assessments used in Kentucky.

Table 2.1

Council for Postsecondary College Readiness Benchmarks

Readiness Score Area	ACT Score	COMPASS	KYOTE
English (Writing)	English 18 or higher	Writing 74 or higher	6 or higher
Reading	Reading 20 or higher	Reading 85 or higher	20 or higher
Mathematics (General Education, Liberal Arts Courses)	Mathematics 19 or higher	Algebra Domain 36 or higher	College Readiness Mathematics 22 or higher

Source: Council on Postsecondary Education. (2012). Senate Bill 1. Retrieved from http://cpe.ky.gov/

COMPASS

The COMPASS math test, also created by ACT, is an online multiple-choice test that evaluates the twelfth grade student's math abilities needed for college math success. The required benchmark for COMPASS, which indicates college readiness, is a score of a 36 out of the possible 100 (ACT "Test Information," 2016). The adaptive assessment has no set number of questions, and the questions are computer generated based on previous answers. Due to its adaptive design, a student can complete the assessment in just under an hour in most cases. COMPASS was once considered effective in college placement because it was diagnostic and could provide accurate data for placing underprepared students in the proper remedial course or this case, the proper intervention (Conley, 2007). The correlation between the ACT mathematics assessment and the ACT COMPASS assessment is not as strong as one would assume. The correlations between ACT and COMPASS ranged from .53 to .73 (ACT, 2010b). This means that both assessments are measuring most of the same skills, but not all the same skills.

KYOTE

The KYOTE is an additional mathematics college readiness assessment requiring a score of 22 out of 31 possible points to achieve college readiness benchmark set by the Council on Postsecondary Education. KYOTE was developed at Northern Kentucky University in collaboration with other university professors (Conn, 2013). It was designed to be free and online. Since it is unique to Kentucky, it is not offered outside of the state. KYOTE has 30 questions on pre-algebra, algebra, and geometry (KYOTE, 2012). The KYOTE can be administered from two to six times during a student's twelfth grade year. This discrepancy is due to the interpretation of the ethical administration code. KYOTE policy and ethical administration code state that the assessment can be taken once per term with the exception being once at the beginning of the term and once at the end of the term (Eakin, 2016)

ACT, COMPASS, and KYOTE Comparison

Even though KDE awards an accountability point for achieving college readiness on COMPASS and KYOTE in the same manner as ACT, the tests themselves are not considered equal (Innes, 2014). In a 2014 report from Kentucky's Office of Educational Accountability, the COMPASS and KYOTE tests are reportedly not as difficult as the ACT (Timmel et al., 2014). COMPASS, a product of ACT, is a standardized assessment also used by Kentucky colleges as a course placement tool. Only since 2012, has KDE accepted COMPASS as a college readiness accountability indicator. KDE allows students to take COMPASS twice during students' twelfth grade year. Students who do not meet the mathematics benchmark score of 36 the first time must be enrolled in an intervention for a minimum of five days before a retake (Timmel et al., 2014).

ACT recently announced that COMPASS will no longer be available as a course placement product due to customer feedback, empirical evidence and postsecondary data showing that it no longer contributes to college readiness success (ACT "Test Information," 2016). However, for the class of 2015, COMPASS was used as a college readiness indicator and included in this study.

The KYOTE is also a college placement and readiness assessment used by Kentucky colleges. KYOTE was created and developed by a team of Kentucky university professors to be free and online. Test security does not match that of COMPASS or ACT due to increased access to the test with little leadership oversight (Timmel et al., 2014). KYOTE test administration is open to policy interpretation regarding the number of times a student can take the KYOTE. The policy states that a student can take the KYOTE two times within each school term as a pretest and then later as a final submission score. This means that if a school on a trimester school calendar may administer the test up to six times a year compared to a school on a semester school calendar may only administer the test up to four times a year (Eakin, 2016). To further cloud equity of college readiness testing opportunities, some schools do not administer the KYOTE due to additional, and complicated setup requirements by the KYOTE, thus denying students of additional opportunities to achieve college readiness status. Also in many schools, the KYOTE practice tests are used as a means of identifying knowledge and skill gaps for accelerated learning instruction and students are repeatedly tested until they pass the practice test before being officially tested. In other words, the test is being used as curriculum in some cases.

In the 2014 study by the Legislative Research Commission (LRC) and Office of Education Accountability, students who achieve college readiness status on the ACT obtain higher Grade Point Averages (GPA) and higher college enrollment rates than students who achieve college readiness status using COMPASS and/or KYOTE (Timmel et al., 2014). As a result, recommendations were made to the Kentucky Department of Education cautioning the use of current multiple College Career Readiness (CCR) measures as the primary indicator for evaluating student progress, program effectiveness or policy impact (Timmel et al., 2014).

In a 2013 study at the University of Louisville, Lisa Conn (doctoral student) compared ACT, COMPASS, and KYOTE for alignment in seven depth of knowledge categories, content demand and cognitive demand to the Kentucky Mathematics College Readiness Expectations for Kentucky's four-year universities. Table 2.2 shows that ACT is the superior assessment for alignment to college readiness expectations while COMPASS and KYOTE flounder in comparison (Conn, 2013). This is the only study that used Conn's method of evaluation consisting of self-administering of all assessments on multiple occasions. Conn created a rubric with the seven depth of knowledge categories and tallied each category corresponding with each test question for each assessment. Conn also measured range of knowledge, balance of representation, cognitive demand and content demand alignment. Conn's evaluation revealed the ACT college readiness assessment superior to other assessments.

Table 2.2

Content and Cognitive Alignment of College Readiness Assessments

Exam	Categorical Correspondence	Range of Knowledge	Balance of Representation	Cognitive Demand Alignment	Content Demand Alignment
ACT	6/7	5/7	7/7	High	Somewhat
COMPASS	5/7	2/7	0/7	Well	None
KYOTE	4/7	1/7	0/7	Well	None

Source: Conn, L. (2013). *Alignment study of Kentucky's mathematics placement examinations and entry level credit-bearing mathematics course examinations* (Doctoral dissertation). Retrieved from http://ir.library.louisville.edu/cgi/viewcontent.cgi?article=1268&context=etd

Looking closer at the categorical correspondence in Table 2.2, it shows that these three assessments do not measure the same content. After analyzing released ACT assessments, COMPASS, and KYOTE online assessments with permission from the test administrators, Conn (2013) found that the ACT had a sufficient representation of test items per content domain in all domains except one. COMPASS had a sufficient representation of test items per content domain in all domains except two. KYOTE had an adequate representation of test items per content domain in four domains but not in three content domains. None of the college readiness assessments had an adequate number of test items in the Number and Quantity domain. ACT was the only assessment with test item representation in geometry; COMPASS and KYOTE had no test items in the geometry content domain (Conn, 2013).

According to Conn (2013), there should be a direct correspondence between the length of the assessment and the 40 standards that need to be assessed. Each standard needs to be assessed with the same quantity of representative questions. This being said KYOTE needs to lengthen their exam to better assess all of the standards well. Also based on this study, it was found that little communication is occurring between the universities and the developers of the college placement examinations, ACT, COMPASS, and KYOTE. Conn (2013) also stated that alignment would occur if all stakeholders developed curriculum and assessments aligned to same updated standards being adopted by Kentucky. Conn's (2013) research also showed that several of the state's core content standards are not being assessed in any of the assessments.

Current college placement assessments are being scrutinized due to the misalignment of modern high school instruction delivery methods and content to traditional algebra skill tests. New college candidates are being assessed over traditional algebra skills even though they received a broad range of mathematics skills such as data analysis, finite mathematics, probability and calculator use as a problem solving tool. Too often, technology and calculators are banned in these assessment situations even though students have learned to use them for problem solving on an everyday basis. Not only did the delivery methods not align to the skills being assessed, but it was also found that the mathematics assessments in 20 states were poorly aligned to some skills and highly aligned in others (Brown & Conley, 2007). After examining the relationship between exams and college placement decisions, Michigan, Illinois, Kentucky and Colorado now require all students to take the ACT (Brown & Conley, 2007).

Transitional Courses and Interventions

Tutoring in interventions has evolved significantly over the past 32 years from Bloom's (1984) face-to-face teacher tutoring to the rapidly advancing modern intelligent tutoring systems with each evolution an increasing effect size on learner outcomes. As research and computer processing advanced, so did the tutoring systems. Once technology began its integration into instruction and tutoring categorized as digital learning tutoring, interactive multimedia tutoring, and intelligent tutoring systems, impact began to increase rapidly as shown in Table 2.3. Bloom (1984) found that teacher provided one-to-one tutoring yielded a 2.0 effect size when compared with group mastery learning. This would prove that one-to-one individualization is a necessary factor in the intervention setting. Given that the average teacher salary is $51,143 a year, and this salary is divided by hours per day per student, one hour of one-to-one tutoring costs Kentucky schools $39 if one teacher worked with one student for one hour per day. This teacher would only be able to teach six students per day which fall extremely below set classroom capacity sizes (KDE School Report Card, 2016).

Transitional courses and interventions add additional liabilities on existing school finances and staffing whether it be hiring intervention staff and/or purchasing proprietary tutoring software subscriptions. The additional financial burden on schools, makes it necessary to optimize the staff to student tutoring ratio. Historically schools have been looking for assistance from technology such as digital learning options to meet individual tutoring needs of students (Dolenc, Aberšek, & Aberšek, 2015).

Early digital learning tutoring consisted of basic drill and practice activities with no intelligent interaction with the learner yielding a .39 effect size. Next, interactive multimedia tutoring increased its interactive capacity but still could not respond and tailor instruction and yielded an effect size of 0.5. Intelligent tutoring systems equipped with artificial intelligence, accelerated learning theory and rapid computer processing speeds yielded effect sizes from .84 to 1.05. (Bloom, 1984; Dolenc, Aberšek, & Aberšek, 2015).

Schools progressed from using only one-to-one face-to-face tutoring, to digital learning tutoring (CAI), to interactive multimedia tutoring, to early versions of intelligent tutoring systems to a modern intelligent tutoring system and finally to a blended model pairing both face-to-face instruction and modern intelligent tutoring system software to provide a comprehensive approach. Table 2.3 illustrates how individualized tutoring has evolved over the past 32 years (Dolenc, Aberšek, & Aberšek, 2015).

Table 2.3

Evolution of Tutoring

Face-to-Face with 1:1 Tutoring	Face-to-Face with 30:1 Tutoring	CAI 1:1 Tutoring	Interactive Multimedia 1:1 Tutoring	Early Intelligent 1:1 Tutoring Systems	Modern Intelligent 1:1 Tutoring Systems
→	→	→	→	→	→
2.0 Effect Size	1.0 Effect Size	.39 Effect Size	.50 Effect Size	Unknown Effect Size	.84-1.05 Effect Size

Source: Bloom, B. S. (1984). The search for methods of group instruction as effective as one-to-one tutoring. *Educational Leadership, 41*(8), 4.

Source: Dolenc, K., Aberšek, B., & Aberšek, M. K. (2015). Online functional literacy, intelligent tutoring systems, and science education. *Journal of Baltic Science Education*, *14*(2), 162–171.

Since tutoring is a specified form of instruction, the results of studies on face-to-face instruction and any online instruction can be transferred over to the tutoring setting. A recent U.S. Department of Education meta-analysis of 50 studies contrasting face-to-face instruction to pure online and face-to-face to blended instruction found that increased student outcomes were produced in both scenarios. The 50 studies were divided into three categories. Category 1 tested face-to-face instruction and pure online instruction while category two tested face-to-face to blended instruction. Category 3 tested pure online instruction with blended instruction. The analyses in category one found no significant difference (mean effect size of +0.05) in pure online instruction and face-to-face instruction. The analyses in category two found that blended learning instruction had significantly stronger outcomes (mean effect size of +0.35) than only face-to-face instruction (Means, et.al., 2010). Category 3 studies found no significant differences in pure online and blended learning overall. The results were vastly different, and no strong conclusions should be drawn from this finding due to the varying instructional elements, content, grade levels, and especially the varying degrees and mixtures of face-to-face and online instruction in the blended learning environments (Means, et.al., 2010). This meta-analysis spanned across all grade levels from Kindergarten to postsecondary graduate students. Generalizations are that online and blended learning is not as effective in lower grade levels and increases in effectiveness as the grade levels increase (Means, et.al., 2010). The presence of the teacher and the foundation of a relationship is vital to student academic performance combined with teacher direction of content-aligned instruction (Gerber, et. al., 2007, Means, et. al., 2010).

The Kentucky legislature passed KRS 158.6459 to provide underprepared students support. Those students previously not meeting benchmarks on assessments such as EXPLORE or PLAN were mandated to be provided documented intervention strategies with this evidence in students' Individual Learning Plans (ILPs) per Senate Bill 130. This means that students must receive college readiness interventions much earlier than their twelfth grade year. Since EXPLORE and PLAN have been retired, new assessments such as ACT Aspire may be used. Then, as eleventh grade students, if they do not meet CPE benchmarks on the statewide administration of the ACT, they are to be enrolled in transitional courses or interventions, also included into their intervention plan. (Patterson, 2016).

The Kentucky Department of Education provides guidance on the content, structure, and implementation of twelfth grade transitional courses and interventions. The content should be aligned to college readiness standards and test measures of the ACT, COMPASS, and KYOTE (Patterson, 2016). However, in a 2010 alignment report by ACT, it was found that the ACT college readiness standards met the Common Core Standards at a rate of 100% (ACT, 2010a). In a more recent white paper released by ACT the researcher claims to assess only those standards that prepare students for college and career readiness. While ACT College Readiness Standards do overlap significantly with Common Core Standards, there was not an exact alignment. This alignment shortcoming leads to curricular and instructional gaps. It was never the intent of ACT during assessment development to align exactly with Common Core Standards (Clough & Montgomery, 2015). ACT assessments were created and developed based on empirical research while the other college readiness assessments cannot make that claim (Clough & Montgomery, 2015).

To address the gaps in content and skills uncovered by the eleventh grade ACT results for each student, the recommended intervention cycle from KDE shown in Figure 2.1 is as follows: (1) student participates in college readiness transitional course or intervention, (2) teacher diagnosis the student's individual content knowledge and skill level with a diagnostic assessment, (3) instructional targets are then developed, (4) direct instruction is provided based on diagnosis and learning targets, (5) knowledge and skills are formatively assessed to monitor progress throughout the intervention, (6) ACT, COMPASS or KYOTE is administered to student again, (7) If the student meets CPE benchmark then the student exits the intervention, or (8) if the student does not meet the benchmark, then the student remains in the intervention until benchmark is met or the next college readiness assessment or graduate (Patterson, 2016).

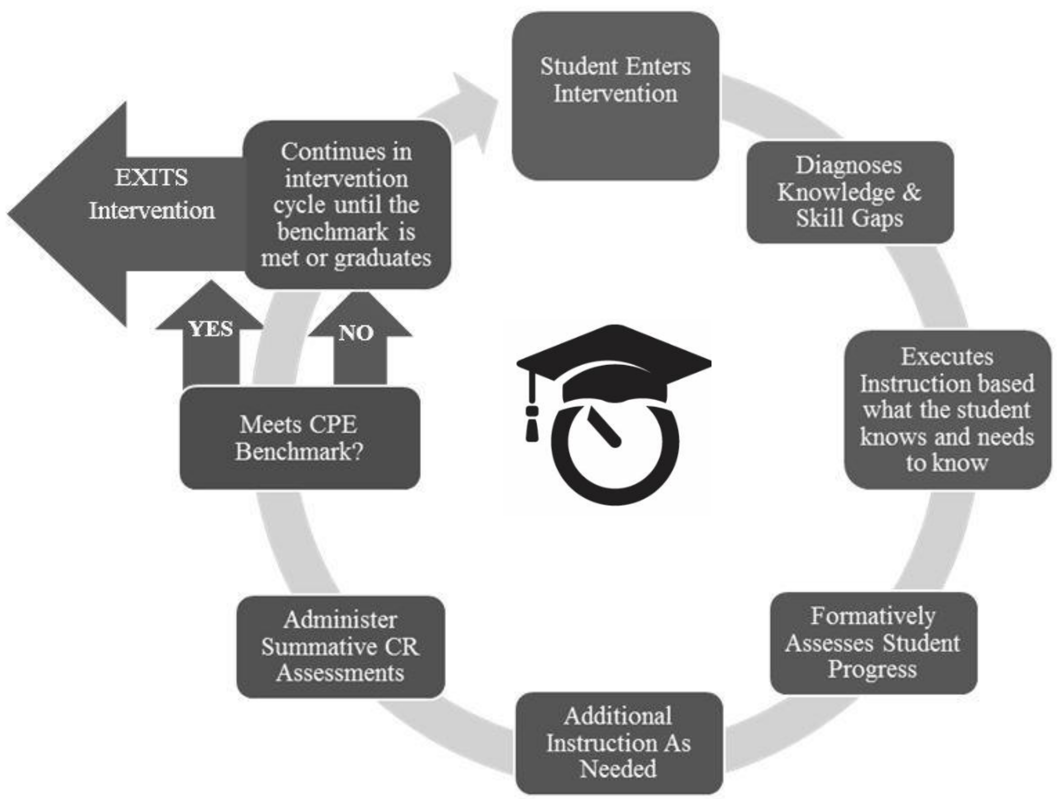

Figure 2.1. Intervention Cycle Based on Accelerated Learning Theory

During the 2014-2015 school year, Kentucky high schools had to provide either transitional courses or interventions for 25,630 twelfth grade students in mathematics (KDE School Report Card, 2016). These are the students who did not score a 19 or higher on the mathematics subtest during their eleventh grade year per legislation and regulation. These transitional courses and interventions focus on the following structural content and are fairly parallel with ACT College Readiness Standards, college or university placement exams such as COMPASS and KYOTE, and the Kentucky Core Academic Standards (KCAS).

Kentucky legislation and regulation mandate schools and districts to provide intervention for underprepared twelfth grade students, but the reality is that not all schools have taken action. The Regional Education Laboratory Appalachia released a formal study March of 2014 on transitional courses in Kentucky high schools revealing that 28.1 percent of underprepared mathematics students participated in transition courses meaning that 72 percent of underprepared mathematics student were not taking transition courses. More than 60 percent of Kentucky high schools were not offering transition courses (Mokher, 2014). This was a cause for concern because it was unknown if these students who were not enrolled in transition courses were being provided interventions. Transitional courses can be tracked through Kentucky course code reporting in Infinite Campus. Dr. Terry Holliday, former Kentucky Commissioner of Education, led the efforts to create the Intervention Tab custom tab in Kentucky's student management system, Infinite Campus. The Commissioner required all third year focus schools to utilize this tab by entering all students and associated intervention details. Specific to this study, every underprepared twelfth grade student in Kentucky must also be entered in the tab with details regarding transition courses and 13 additional data elements. For this study, the researcher used data elements that describe the delivery system, intervention materials, and results of the intervention. (Holliday, 2014).

Why Some Interventions Do Not Work

When a student is placed in an intervention or developmental course and the results are unsuccessful, it is due to one or more of four reasons: (1) student placement error or misdiagnosis of knowledge and skill, (2) low quality curricula, (3) ineffective pedagogy, or (4) external distractions and circumstances (Jaggars, Hodara, Cho, & Xu, 2015). Student placement errors result from placement exams providing only one measure of content knowledge and skill which can either place students in courses too low or too high than actual achievement level. Low quality curricula can cause a student to lose interest in the course and become disengaged. Some curricula focus in one particular subskill that the student may not need and cause the student to become unclear as to the relevance of the instruction. Ineffective pedagogy occurs when the teacher or software does not present material using best practices. Lastly, the reason with the most impact is external distractions and circumstances. External distractions such as disruptive home life, social issues, and daily survival activities can cause a student to be absent, tired, and not mentally prepared to learn (Jaggars et al., 2015). There are many factors that impact the success of an intervention, but for this study, the focus will be finding the association between delivery method of the intervention and college readiness achievement status.

Mathematics Intervention Practices

The underpinnings of interventions are sound instructional practices. While general instruction is conveyed at official grade level to all students, interventions are designed to meet the students at their level of achievement filling in knowledge and skill gaps. The delivery methods of interventions, just like instruction, lie along a continuum from face-to-face instruction only to online/digital tutoring instruction only (Patchan et al., 2016).

In 2008, John Hopkins University conducted an analysis and then published a review of 102 studies including studies of mathematics curricula, computer-assisted instruction and instructional process programs to create a synthesis of interventions that work best for secondary students (Slavin, Lake, & Groff, 2008). This review found that mathematics curricula had a +0.03 effect size on student mathematics intervention achievement. Computer-assisted mathematics instruction had a +0.8 effect size, and instructional process programs had a median effect size of +0.18 (Slavin, Lake, & Groff, 2008).

When assessed individually, certain interventions had a greater effectiveness regardless of their classification. The researchers ranked the interventions into effectiveness ratings based on evidence of strong, moderate, limited and insufficient. Two of the 40 instructional processes that utilized cooperative learning group instruction had a strong effectiveness rating. None of the interventions rated in the moderately effectively category. Four of the Computer Assisted Instructional interventions such as Cognitive Tutor, Expert Mathematician, Jostens, and Plato were rated as positive, yet limited, in their effectiveness. In the mathematics curricula category, Core Plus Math, Math Thematics, Prentice Hall Course 2, and Saxon Math had limited effectiveness. Instructional processes interventions with limited effectiveness include Partnership for Access to Higher Mathematics (PATH) and Talent Development Mathematics (Slavin, Lake, & Groff, 2008).

To further facilitate the use of digital learning as an option for interventions, states are establishing college and career readiness policies as well as digital learning policies to improve student access to high quality content and instruction leading to increased college and career ready preparedness (Blume & Zumeta, 2013). Now, many Kentucky secondary schools are progressing toward reliance on varying intervention tutoring systems to diagnose and personalize intervention instruction to fill these knowledge and skill gaps in mathematics leading to college readiness status achievement.

Research is showing that it is simply not enough for the tutorial software to be technology-based or interactive multimedia, it must be highly personalized with artificial intelligence processing (Dolenc, Aberšek, & Aberšek, 2015). Knowledge and skill gaps can be addressed through the integration of an intelligent tutoring system software (Wang, Han, & Yang, 2015). The face-to-face teacher/student individual knowledge and skill diagnosis, instructional planning process, an assessment with feedback loops require an enormous amount of time and mental resources of the instructor. Pairing intelligent tutoring with face-to-face instruction could be an efficient solution to implement the accelerated intervention.

The current and relevant literature discuss how intelligent tutoring system software increases mathematics achievement limited to only a few software vendors but not the correlation of comprehensive Blended learning models that include artificial or intelligent adaptive mathematics software being implemented as an intervention (Means, Toyama, Murphy, & Baki, 2013).

Three Intervention Tutoring Delivery Methods

The delivery method of an intervention is only one key factor in the success of an intervention. In Kentucky, the three delivery methods are: (1) face-to-face tutoring, (2) digital or online tutoring, or (3) blended learning tutoring. While face-to-face tutoring includes the fluid and intuitive teaching of an expert capable of building a relationship, the human is quite limited timewise in performing one-to-one instruction and assessments and must serve large groups of students as high as 30 students in one classroom. This is where online or digital learning tutoring comes to the rescue. Online or computer tutoring does not automatically produce an increase in achievement; it must be paired with sound teaching and learning designed and implemented by a teacher (Li & Ma, 2010).

Face-to-Face Tutoring Only

Face-to-face tutoring is described as an adult content expert working one-on-one with a student. It is believed that face-to-face one-to-one tutoring is more effective that computer tutoring in general due to the immediate and intuitive communication exchange between the teacher and the student (VanLehn, 2011). VanLehn's (2011) study was based on Bloom's (1984) tutoring study commonly referred to as the 2-Sigma study due to his +2.0 effect size results. VanLehn's (2011) study did not get the same results as Benjamin Bloom in 1984 due to the expert level of Bloom's tutors versus the novice level of many of VanLehn's tutors. VanLehn's (2011) results showed a +0.79 effect size which is still considered highly effective.

Online/Digital Learning Only Tutoring

Before the union of technology and education, information development was sluggish. Technology and digital learning have increased information development exponentially to the point knowledge have acquired a half-life (Siemens, 2005). Digital Learning involves the use of technology to deliver knowledge at the student's own pace, place, time, and path, involving digital devices, digital content and guiding instruction (Digital Learning, 2016).

Digital Learning is a central term used to describe instruction via tutorials, communication media, exploratory environments, tools, and instructional management software (Li & Ma, 2010). Digital learning takes place using a digital device such as a personal computer workstation, laptop, tablet, Chromebook, game station, or smart phone, all increasingly accessing the Internet for the delivery method. Content can be delivered by the installation of application or program or access to programs online. Tutorials consist of digital learning instruction (CAI) which simply and directly teach mathematics through demonstration, information, drill and practice (Li & Ma, 2010). Mathematics games with drill and practice tend to be effective in teaching exceptional children basic mathematics facts leading to increased accuracy and performance (Li & Ma, 2010). Digital mathematics interventions can also be delivered using information communication technology (ICT) such as e-mail and videoconference. Exploratory environments such as multimedia, problem solving multimedia, hyper-media programs, and simulations are also used to deliver intervention instruction. The list of digital learning tools is vastly ranging from apps to Microsoft Office tools to programs such as Geometer's Sketchpad, virtual manipulatives and data analysis software. Lastly, it is instructional management software which is used for both instruction and assessment and can be individualized to meet the students' needs.

In the evolution of digital learning tutoring, programs with artificial intelligence and adaptability are proving to be able to diagnose, interact, design instruction, formatively assess while communicating progress to both student and teacher Bartlett, J., et. al., 2016, Botsios, S., et. al., 2008, Bregant, J., et. al., 2014).

Blended Learning Tutoring

Blended learning has been the topic of much rhetoric for the past decade as an approach to increasing the global education of students (Li & Ma, 2010). Blended learning combines intuitive face-to-face instruction with high-quality online knowledge spaces filled with congruent standards-based content and instructional media accessible anytime, anywhere and at the chosen pace of the individual learner. Blended learning is generically used to describe a learning system puzzle as a whole with comprising interacting subsystems of the learner, instructor, content, context, delivery method, time frame, and learning goals (Wang, Han, Yang, 2014, Means, et. al., 2010).

Currently, six models of blended learning (face-to-face, rotation, flex, online lab, self-blend, and online driver) exist with the new flipped classroom model proving success through research and taking its place along side of the six original models (Staker & Horn, 2011). While past theory and practice have defined the six original models, practitioners in the field may fluidly design and implement new models based on student learning needs.

Much of the blended learning research has been qualitative in design examining student experiences with the instructional delivery method. In 2012, Gecer and Dag studied student views of a blended learning course when compared to other mathematics courses utilizing just face-to-face or e-learning methods. Students communicated the positive effects of blended learning in regards to grading, anytime access to course content, communication, and autonomy in learning activities within the Learning Management System(LMS) of the blended learning course (Gecer & Dag, 2012).

When technology and blended learning are combined with systemic project-based learning, students in one high poverty high school demonstrated an increase in graduation rates from 63 percent to 87 percent over a two-year period. Occurring coincidentally were decreases in suspensions, alternative school referrals, failures and dropout rates (Darling-Hammond, Zielezinski, & Goldman, 2014).

In a 2007 study testing the impact of the type of collaboration activities (content, interpersonal, or organizational) between tutors and students in a blended learning course and student performance on the final exam had surprising results. This study found that the interaction with the greatest impact on student performance was the interpersonal interactions over both content and organizational interactions (Gerber, Grund, & Grote, 2007).

Several quantitative meta-analyses have been conducted to test the benefits of blended learning compared to face-to-face and pure online/digital learning instruction. A 2010 meta-analysis found that 23 studies resulted in the findings that blended learning had a +0.35, $p<.001$ effect size when compared to pure online/digital instruction which is greater than the 27 studies comparing pure online/digital comparison to pure face-to-face which had an effect size of +0.05, p=.46 (Means, et. al., 2010).

Those students participating in blended learning showed a significant advantage over those students participating in pure face-to-face instruction. The advantage was much less significant when comparing pure online learning with face-to-face instruction (Means, et. al., 2013).

Integrating Intelligent Tutoring into Blended Learning

Providing the high-quality content with human intuitive and responsive instruction meets the needs of the masses, but does not truly meet the complex individual needs of the underprepared mathematics student with multiple content knowledge and skill gaps; this is where artificial intelligence can efficiently fill in the learning gaps (Russell & Norvig, 1995). Multiple research studies have found that many online tutoring systems and online intelligent tutoring systems can mimic the human one-to-one tutoring in that online tutoring systems can diagnose, set learning targets, design an instructional path, formatively assess student progress, update learning path and summatively assess mastery while communicating progress to both the student and the teacher. (Serçe, Alpaslan, & Jain, 2008, Wang, Han, & Yang, 2015).

Mathematics tutoring software with artificial intelligence is reliant on student knowledge inputs. Using these knowledge inputs and an interaction algorithm, the software can diagnose individual student knowledge and skill gaps, map the corresponding learning path, provide frequent assessment, and remap the learning path after each assessment. Blended learning strategies, support systems and policies of learning institutions are constantly evolving in response to the progressively blended learning research (Wang, Han, & Yang, 2015).

In 2006, mathematics achievement was found to be directly correlated to mathematics attitude and by delivering mathematics content using a blended learning approach, student attitudes toward mathematics significantly improved (Yushau, 2006, Canfield, W., 2001). A study in 2013 examined the impact of ALEKS used in an emporium mathematics setting to determine if there were differences in course final examination scores of students in ALEKS emporium math lab and those who did not participate in ALEKS emporium math lab (Hrubik-Vulanovic, 2013). In an emporium style math class implementation varies, but in generally identified students report to a lab of computers to engage in tutoring software while mathematics student tutors are available as needed a ratio of one tutor to 25 students (National Center for Academic Transformation [NCAT], 2006). The effectiveness of the emporium math lab has varied over time due to the varied instructional elements that can be present.

Encompassing Digital Learning Research

With the increase of technological capacity, more and more online tutoring systems are being developed, and the efficiency is increasing with the advancement of research and computer processor speeds (Dolenc, Aberšek, & Aberšek, 2015). Many online tutoring systems and online intelligent tutoring systems can mimic the human one-to-one tutoring in that online tutoring systems can diagnose, set learning targets, design an instructional path, formatively assess student progress, update the learning path and then summatively assess mastery while communicating progress to both student and teacher. (Serçe, Alpaslan, & Jain, 2008, Wang, Han, & Yang, 2015).

In an 2011 meta-analysis by John Hopkins University, this evolution, and increasing effectiveness was proven initially. Improving the methodology of their 2008 study, Cheung and Slavin (2013) reviewed additional educational technology programs and found differing results. For example, from 1966-1972, computer assisted intervention instruction had an average effect size of +0.24. From 1974-1984, the effect size was +0.36.

In the studies following, a negative trend occurred over a 14-year time span from 1969 to 1998 dropping the effect size from +0.73 to +0.36. When broken down into the three types of educational technology used for interventions in this study, supplemental computer-assisted instruction had an effect size of +0.18, while computer-management learning had an effect size of +0.08 and comprehensive programs had a smaller effect size as well at +.0.07 (Cheung & Slavin, 2013).

Cost of High School Intervention Tutoring

The average high school teacher teaches four to six classes per day averaging between 25-30 students per class period over a seven-hour work day with 6 hours of instruction. The average teacher salary in Kentucky for 2014-2015 was $51,000 per year (KDE Open House, 2016). This divides out to $39.00 per hour or $273 per day. In an ideal tutoring situation, one-to-one face-to-face instruction for one student per hour is $39 per hour. Realistically, in public schools, it is not cost effective to provide one-to-one, face-to-face tutoring instruction to its underprepared students. The districts in this study purchased two different types of tutoring software: course software at $23 per student per year and intelligent tutoring software at $39 per student per year making it an average cost of $31 per student per year. Intelligent tutoring software directly aligns with the accelerated learning and cognitive load learning theories while course software aligns with limitations in its individualization, adaptive and personalization features.

Blended learning requires the face-to-face instructor thus costing more than the pure online/digital courses. In a 2013 meta-analysis of the three instructional delivery methods, the cost savings of pure online/digital learning could not be justified due to the low effect size when compared to instruction with a face-to-face teacher (Means, et. al., 2013).

Table 2.4 represents the approximate costs for five hours of intervention tutoring per hour, per week, per semester and year. The calculations in Table 2.4 were derived from the average yearly salary of a teacher and the average cost of online/digital tutoring software per student per instructional contact hour. These expenses are additional costs to existing core instruction.

Table 2.4

Cost of Tutoring for 5 Hours Per Week

5 Hours of Tutoring Per Week	Hourly	Weekly	Semester	Yearly
1:1 Face-to-Face (5 hrs)	$39.00	$195.00	$2,106.00	$4,212.00
30:1 Face-to-Face (5 hrs)	$1.30	$6.50	$117.00	$234.00
Online/Digital Only (5 hrs) *	$0.17	$ 0.86	$15.50	$31.00
Blended Learning (2 hrs of 30:1 F2F + 3 hrs of Online) *	---	$3.11	$55.98	$111.96

* Does not include hardware and networking costs

If one student received five hours of one-to-one, face-to-face tutoring from a teacher each week, this would cost the district or school $2,106.00 per semester. Face-to-face with a 30:1 student to teacher ratio would cost $117.00 per semester, online/digital learning would cost $15.50 per semester, and blended learning tutoring would cost $55.98 per semester.

Kentucky's Digital Learning Report Card

During the years of 2011-2014, Digital Learning Now (an ExcelinEd initiative) released their Digital Learning Report Cards evaluating every state on ten elements of Digital Learning: student eligibility, student access, personalized learning, advancement, quality content, quality instruction, quality choices, assessment and accountability, funding and delivery. Kentucky did not rank well on this national report in comparison to the other 49 states. In 2014, Kentucky scored 65% with a "D" letter grade with 16 states ranking lower. This letter grade was an improvement over the "D –" earned in both 2012 and 2013 (Digital Learning Now, 2012, Digital Learning Now, 2013, Digital Learning Now, 2014). Kentucky did earn an "A" ranking in three of the ten elements: quality content, quality instruction, and delivery. On the opposite end of the grading scale, Kentucky earned "F" rankings in student eligibility, student access, quality choices, assessment and accountability, and funding (Digital Learning Now, 2014).

Digital and Blended Learning Policies

Kentucky's General Assembly always has a full agenda of issues to review, but not when it comes to digital learning in education**.** Between the years of 2011-2013, 12 digital learning bills were proposed, of which 6 of those were enacted, and six died. The most significant bill was signed in 2012 by Governor Steve Beshear. House Bill 37, empowered Kentucky schools and districts with more autonomy to implement innovative instructional practices. This bill could open opportunities for implementing new blended learning models of instruction and learning leading to increased college and career readiness for Kentucky students (Acree & Fox, 2015). After 2013, digital learning policy and legislation stalled out. No bills related to digital or blended learning were found in documents describing enacted legislation for years 2014-2016 (Digital Learning Now, 2013, Digital Learning Now, 2014, Digital Learning Now, 2015; KDE, 2015, 2016).

Digital and Blended Learning Policy Guidance

Kentucky ranks in the lower quartile in the nation regarding digital learning policy and implementation (Digital Learning Now, 2013, Digital Learning Now, 2014, and Digital Learning Now, 2015). With that being said, there are states with promising policies to explore and examine for possible future digital learning policies in Kentucky. Advancing technological capacity lends itself to advanced personalization learning to increase equity and access just in time to meet their academic goals. Personalization with targeted interventions meets underprepared students where they are to facilitate success and goal achievement. Scaling up digital learning can be thwarted by existing state education policies such as seat-time restrictions, graduation requirements, teacher certification and licensure requirements, funding guidelines, curriculum, assessment and accountability (Patrick, Worthen, Frost, & Gentz, 2016). Kentucky has started the process on a small scale to maneuver around such policy obstacles with the innovation initiatives and House Bill 37 to grant the flexibility needed. While Kentucky has not directly labeled this policy digital learning, it will provide pathways for increased digital learning practices.

Some states such as Arkansas authored and enacted model digital learning legislation titled the Arkansas Digital Learning Act (Arkansas Digital Learning Act, 2013). This substantial piece of legislation for Arkansas students provides for expanding digital learning opportunities to all students with the removal of obstacles. To ensure high-quality digital learning content, the Arkansas Department of Education will provide an approved list of digital learning providers annually to the House Committee. Digital Learning content must meet or exceed all state-adopted curriculum standards and requirements. This content must align with and be measured by both standardized and local assessments. To facilitate individualization, digital content must be tailored to meet the needs of each student. Highly qualified teachers must deliver all digital learning courses to any and all students. (Arkansas Digital Learning Act, 2013). The Arkansas Digital Learning Act directly aligns with Kentucky's Digital Learning Guidelines which were disseminated by former Kentucky Commissioner of Education, Terry Holliday in 2014 (Combs, 2014, Arkansas Digital Learning Act, 2013). The Kentucky Digital Learning Guidelines were provided only as a directive to schools and districts.

Potential for model digital learning policy exists within the provisions of ESSA. For teachers to successfully implement digital and blended learning, professional learning support must be available. States, districts, and schools must provide professional learning to teachers on effective digital and blended learning practices. Micro-credentials are competency-based certifications that can be earned through personalized experiences, projects, and products that provide evidence of competencies mastery (Pace & Worthen, 2014). Micro-credentials are similar to digital badges used to recognize and provide evidence of very specific knowledge and skill mastery.

Patrick, S., et. al., 2016)

Guidance for Leadership Practices

In 2013, the Kentucky Department of Education released Kentucky's Digital Learning Guidelines. These guidelines were the vision of former education commissioner, Dr. Terry Holliday. They were to serve as guidance for school and district leaders to use when selecting or developing instructional digital learning resources all across Kentucky. They were also developed as the foundation for future state digital learning policy that has yet to evolve. Expectations were that digital learning resources used in digital and blended learning opportunities were to meet or exceed the quality of effective face-to-face instruction. The guidelines also require a highly qualified professional to review and endorse any and all online/digital learning resources used in instruction. Such rigorous screening and implementation of high quality online/digital learning resources are expected to contribute to increased student engagement, achievement, gap closure, and college and or career readiness (Combs, 2014).

Kentucky's Digital Learning Guidelines also established five guiding principles that communicate the vision of these guidelines. First, a highly qualified teacher must select appropriate digital instructional resources. Second, a highly qualified teacher must steward student achievement. Third, highly qualified teachers must be accessible to students enrolled in any digital learning opportunities. Fourth, individualized instruction must be based on student diagnostic data, learning styles and needs manifested via student choice, voice, and pace. The final principle commands that the face-to-face teaching practices prescribed by the Professional Growth and Effectiveness System equal or exceed teaching practices utilizing digital and blended learning practices (Combs, 2014).

Adaptive, Personalized, and Individualized Learning

Adaptive, Personalized and Individualized Learning (APIL) meet students where they are and delivers instruction tailored to those needs which adjusting to each student's learning pace. Digital learning technologies, when used in concert with face-to-face instruction (for blended learning), can scale up APIL leading to drastic student achievement increases (Patrick, Kennedy, & Powell, 2013). It is challenging for a face-to-face instructor to individualize, adapt and personalize instruction for a class of 30 students without high-quality technologies to assess current knowledge with instant data, provide a variety of resources and learning materials, plus additional opportunities for practice with immediate feedback for each student. With the increase of educational technology capacity, the utilization of personalized learning has increased (Pane, J. F., et. al., 2015). The digital learning technologies are not the answer, they merely enhance and empower educators to better support their students (Patrick, Kennedy, & Powell, 2013).

Accelerated Learning Theory

The Accelerated Learning approach is based on the Accelerated Learning theory. Accelerated Learning has many definitions in reference to instructional strategies and has evolved since its first introduction by Bulgarian research psychiatrist, Georgi Lozanov and Harvard educator, Howard Gardner (Imel, 2002, Bonanno, 2000). An intervention designed using Accelerated Learning reorganizes instruction and curricula in a manner that provides students only the concepts they need to master in a condensed, streamlined, and rapid manner to provide students only what they need to master built upon the multiple intelligence theory, learning styles research and collaborative learning (Edgecombe, 2011, Imel, 2002).

Other systems of Accelerated Learning include the offering of college level knowledge and skills at the high school level through programs such as Advanced Placement, dual credit courses and middle college schools (Effective Strategies for Accelerated Learning, 2012). The Accelerated Learning approach highlighted in this study is the one that integrates with the intervention system due to individualization of learning needs, shortened instructional time frame and increased intensity of learning that needs to occur during targeted intervention tutoring (Imel, 2002). Supplementary stated as a method by which the student with knowledge and skill gaps are provided targeted instruction only on the areas of deficiencies. By building on previous knowledge and streamlining instruction the student is not subjected to cognitive overload that occurs when a student is subjected to repeat an entire course (Accelerated Learning, 2011).

Additionally, accelerated learning is an adult learning theory which makes it appropriate for twelfth grade students who are adults or on the cusp of adulthood. Accelerated learning can further be described as using the individualization as described above with results being achievement of learning in a shorter amount of time or a greater amount of learning in the same amount of time. When accelerated learning is applied to instructional design it decreases cognitive overload by only teaching what the students need to know and what they are ready to learn (Plass, Moreno, & Brünken, 2010; Paas, Renkl, & Sweller, 2003). Regardless of the instructional delivery method, it is possible to reduce cognitive overload by diagnosing knowledge and skill levels, teaching only needed content and skills instead of the content and skills of an entire possibly redundant entire course or a course that is above students' processing capacity (Mayer & Moreno, 2003).

Cognitive Load Theory

Cognitive load describes the relationship between mental effort and working memory capacity. If too much or too complicated content with few prior knowledge connections is being presented to students, then the student's working memory capacity may not retain the content. Cognitive Load Theory developer, John Sweller, contended that efficient instructional design can reduce cognitive load (Chandler & Sweller, 1991). Three forms of cognitive load play unique roles in long-term learning. Intrinsic, extraneous and germane need to work in harmony and balance to effectively free the working memory capacity to allow the learner to use newly acquired knowledge in more advanced representations (Chandler & Sweller, 1991; Sweller, 2015). This complex balancing act is dependent upon the instructional design being tailored to the learner. This means that learning must be individualized, adaptive, and personalized (Chandler & Sweller, 1991; Sweller, 2015). One method highlighted as being effective with novice learners is the worked example strategy. By providing a worked example, the novice learner can quickly make the connections and commit problem solving to working memory quicker than if the learner had to figure it out on their own (Sweller, 2015). It has been found that providing individualized, adaptive, and personalized instruction using face-to-face methods limits the efficiency of instruction. Blayney, Kalyuga, and Sweller (2015) found that technology was necessary to provide the type of individualized, adaptive and personalized instruction necessary for large scale instruction.

Accelerated Learning and Cognitive Load in the Digital Age

Accelerated Learning addresses the specific knowledge and skill gaps while building on the existing knowledge and skills of the learner. Other supporting learning theories such as behaviorism, cognitivism and constructivism are considered broad and established before the integration of technology into learning (Siemens, 2005). The Connectivism Learning Theory is rising in educational awareness and practice along with the rise of digital and blended learning. The Connectivism learning theory is based on the principles that learning is fluid and highly responsive to diverse opinions. It relies on connectedness to specialized nodes of information, and the principle that learning can exist in artificial nonhuman organizations and appliances (Siemens, 2005). Link the Connectivism theory with the Complex Adaptive Systems Learning Theory (CABL) and it fits into the practice of personalized digital and blended learning (Wang, Han, & Yang 2015). With modern digital learning, all of these theories have been reigned in to underpin the accelerated learning theory. This theory is the foundation for implementing a highly effective intervention system whether it be face-to-face, online or blended. Both Cognitive Load Theory and Accelerated Learning Theory can be intertwined with the right technology to provide prescriptive solutions for individualized, adaptive, and personalized tutoring.

Learning System Structures for College Readiness

The unification of school improvement strategies and the essence of the Every Student Succeeds Act, rigorous curriculum and instruction is expected to lessen the state of college readiness underpreparedness (Plunkett, 2016). High schools across the United States are using evidence-based strategies to increase mathematics rigor leading to college readiness such as Advanced Placement (AP) courses, higher-level mathematics courses, dual enrollment courses, and early college high school programs. (O'Brien & Dervarics, 2012). According to an ACT study, it was found that the more rigorous and higher level the high school mathematics courses the higher the ACT mathematics score (ACT, 2010b).

It was found that leadership style had a significant correlation to the implementation of RtI. Also, the transformational leadership style was the greatest predictor of RtI implementation, then transactional and passive respectively. Recommendations made to the 106 schools to improve the quality of the intervention system included: (1) high school interventions must be led by highly qualified teachers, and (2) implement with appropriate group size corresponding with the age and student needs. Recommendations were also made to 110 schools to improve their monitoring of fidelity of implementation (Maier et al., 2016).

Conclusion

College readiness achievement for our high school graduates is an accomplishment of exponential magnitude leading to college success and persistence. When twelfth grade students enter their final year of high school underprepared, state policy requires intervention and additional opportunities for college readiness assessment retakes. Kentucky's three college readiness assessments are not equivalent in comparison to each other in content, length or difficulty. KDE has put an informal accountability system in place for tracking the provisions and progress of these students using the intervention tab. The assessments used as college readiness indicators vary by rigor utilization, alignment, and college readiness results. The blended learning delivery method aligns with both the Accelerated Learning Theory and Cognitive Load Theory. Blended learning instruction and tutoring have shown to have the greatest impact on learner outcomes connected to college readiness than face-to-face or online intervention instruction only (Patchan et al., 2016). Past research has shown that while all have positive effects, blended learning yields the highest effectiveness and efficiency on achievement with face-to-face tutoring coming in second and digital learning only coming in third. To ensure that our students are being provided the best possible preparation opportunities for college readiness, model leadership practices and policies need to be examined and enacted in Kentucky.

Chapter 3: METHODS

Research Method and Design

The purpose of this retrospective quantitative study was to determine the association between achievement on college readiness assessments and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face only, (2) online or computer assisted tutoring, or (3) blended learning tutoring.

Research Questions

Q1: What is the association between achievement on the ACT college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015 (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

> **$H1_0$:** There will be no association between the mathematics college readiness achievement on ACT of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.
>
> **$H1_a$:** There will be an association between the mathematics college readiness achievement on ACT of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

Q2: What is the association between achievement on the COMPASS college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

$H2_0$: There will be no association between the mathematics college readiness achievement on COMPASS of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

$H2_a$: There will be an association between the mathematics college readiness achievement on COMPASS of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

Q3: What is the association between achievement on the KYOTE college readiness assessment consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

$H3_0$: There will be no association between the mathematics college readiness achievement on KYOTE of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

$H3_a$: There will be an association between the mathematics college readiness achievement on KYOTE of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

Q4: What is the association between achievement on any of the college readiness assessments consequential to the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring?

> **$H4_0$:** There will be no association between the mathematics college readiness achievement on any college readiness assessments of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.
>
> **$H4_a$:** There will be an association between the mathematics college readiness achievement on any college readiness assessment of the underprepared twelfth grade students and the intervention delivery method: (1) face-to-face tutoring only, (2) online tutoring only, or (3) blended learning tutoring only.

Participants and Setting

The participants in this study consist of 795 underprepared twelfth grade students across four Kentucky school districts representing six high schools. The participating districts volunteered to provide data files requested by the researcher. District participation was dependent upon available resources, time, and staff with database extraction skills to assist in this research study.

The sample represented in Table 3.1 represents the sample students with assessment and intervention data records four districts representing six high schools. District 1 shared student data from one high school previously in priority status with a sample size of 89 students. District 2 shared student data from one high school also previously in priority status with a sample size of 330 students. District 3 shared student data from all three high schools in the district, none of which were in priority status. District 4 shared student data from one high school in the district previous in priority status with a sample size of 49 students.

Table 3.1

Sample N Counts by District

District	N	Percent
District 1	89	11.2
District 2	330	41.5
District 3	327	41.1
District 4	49	6.2
Total	795	100.0

As stated earlier, each school and district has the freedom to select the curriculum, materials, and instructional methods for providing interventions to the underprepared students. This is evident in Table 3.2 that shows how the schools and districts provided mathematics interventions to their underprepared students. Districts 1 and 4 provided blended learning tutoring to 100% of their underprepared students. District 2 provided the majority of their underprepared students face-to-face tutoring. District 3 reflects more evenly distributed provisions of interventions with face-to-face still being the intervention provided to the majority of students, and just under half of the students being provided either online/digital tutoring or blended learning tutoring.

Even though this study did not compare districts against each other, the choices made by the school and district leadership are interesting and worthy of discussion in terms of professional leadership practices.

Table 3.2

Distribution of Intervention Delivery Methods by District

	1*		2*		3*		4*	
	N	%	N	%	N	%	N	%
Face-to-Face	0	0	306	93	191	57	0	0
Online/Digital	0	0	17	5	35	10	0	0
Blended Learning	89	100	7	2	111	33	49	100

**Note: District 1 represents 1 high school of 2 existing high schools in the district. District 2 represents 1 high school out of the 5 existing high schools in the district. District 3 represents all 3 existing high schools. District 4 represents the only high school in the district.*

Table 3.3 represents the descriptive statistics for the mean eleventh grade ACT scale score for the class of 2015. The mean ACT scale score is 15.99 with a standard deviation of 1.350.

Table 3.3

ACT Mathematics Eleventh Grade Scale Score Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ACT Scale Score: eleventh Grade	795	10	18	15.99	1.350

Table 3.4 represents the Eleventh Grade Mean Mathematics ACT Scores by District.

Table 3.4

Eleventh Grade Mean Scale Score by District

District	Mean	N	Std. Deviation
District 1	15.91	89	1.249
District 2	16.09	330	1.331
District 3	15.92	327	1.427
District 4	15.90	49	1.104

Variables

The independent variable of focus in the study was the Kentucky intervention delivery method type comprised of face-to-face tutoring, online tutoring and/or blended learning tutoring (Kentucky Department of Education, 2014). Extraneous independent variables that revealed a connection to college ready achievement consisted of the type of assessment used to measure college readiness, intervention type and school priority status. In the cases of interventions using software, a comparison of software will be explored as well. The dependent variables in all analyses were the mean scale scores on college readiness assessments for participating students in the graduating class of 2015 and the status of college readiness. College readiness assessments for mathematics available to all schools are ACT, COMPASS and KYOTE. However, the degree to which each school utilize these assessments varies by school.

Data Collection

Data was collected from the student level data files of districts volunteering to participate in this study. The Kentucky Department of Education recommended several districts for my study due to high data quality and high-quality intervention systems. Recruitment emails (Appendix B) were sent to 16 school districts of which four districts representing six high schools agreed to participate and shared student data files. The student data for the Class of 2015 already existed within the district student management database. The researcher used IRB guidelines to request and obtain the existing data. The following student data files were requested and received with varying degrees of completeness:

(1) Class of 2015 10th Grade PLAN scores for school year 2012-13, (SSID, PLAN Score -, Math,)
(2) Class of 2015 - 2014 eleventh grade statewide ACT administration (Data Elements in the 2014 eleventh grade statewide ACT administration will include: (1) SSID, (2) school code, (3) district code, (4) grade level, (5) gender, (6) ethnicity, (7) Sp Ed, (8) ELL, and (9) FRPL for Mathematics.
(3) Class of 2015 ACT super scores for twelfth grade students, (SSID and ACT super score) for Mathematics.
(4) Class of 2015 COMPASS super scores for Mathematics.
(5) Class of 2015 KYOTE super scores for Mathematics.
(6) Infinite Campus Intervention Tab extract for 2014-15 school year for twelfth grade students only including the following data elements: (1) SSID, (2) content area – English, mathematics & reading, (3) transition or intervention (4) intervention type, (5) intervention materials, (6) intervention delivery method, (7) frequency, (8) duration, and (9) instructor type.

(7) Also the data file on Class of 2015 - (1) SSID of all students enrolled in a transitional course for English, Mathematics and/or Reading with course description, and delivery method, duration, frequency, teacher type, materials, etc.

Once the data was received, varying degrees of data completeness were observed, especially in terms of the intervention tab data. Completeness of data elements entry varied by school. When data omissions were discovered, the researcher contacted the superintendents' data designees who quickly searched for and then provided the missing data if available. When all student data files were merged, there were 1331 raw cases, after deleting or combining duplicate cases. Also deleted were cases of student withdrawals and missing data. The final number of valid cases totaled 795.

Statistical Analyses Models

This study engaged descriptive statistics, bivariate correlation, and statistical significance research methods. Descriptive statistics were used to determine the mean scale scores for students who did not meet CPE benchmark on the eleventh grade ACT statewide administration in mathematics, grouped by district and priority school status. Descriptive statistics were used once again to determine the mean scale super scores for students who took the ACT, COMPASS and KYOTE in the twelfth grade. For each of the Kentucky college readiness asssessments, further descriptive analyses were conducted based on priority school status, intervention type, and delivery method of the intervention. Chi Square Descriptive Crosstabs and Fisher's Exact Test were used to explore the association between college readiness benchmark achievement status for each assessment by the intervention delivery method. Also of importance to this study was the bivariate correlation between the assessments used in Kentucky to measure college readiness in mathematics.

Assumptions

In this study, the researcher made the following assumptions after conversations with teachers and school leaders in each school:

1. Only highly qualified teachers were providers of twelfth grade mathematics interventions.
2. Interventions were provided for one hour per day every day until college readiness benchmark was met.
3. Curriculum for transitional courses and interventions contained appropriate content that met the needs of each student and met state approved academic standards.
4. Blended learning ranged from a 70/30 to a 60/40 split of face-to-face instruction and online/digital learning instructional time.
5. Accelerated learning processes are implemented in each and every intervention classroom.

Limitations

The limitations recognized in this study were that the researcher did not control for student socioeconomic background, duration of the intervention, teacher quality of the intervention, low number of participating districts and schools, no control for the number of test administrations per student. First, the researcher did not control for student socioeconomic background due to district interpretation of federal limitations on the release of this type of student data. Due to local policy, two districts allowed the release of this data to the researcher while two districts did not. The duration of the interventions varied greatly by student because the students were enrolled in a mathematics intervention until the students met benchmark on one of the college readiness assessments. Again, two districts provided this data while two did not. Teacher quality for the intervention was not controlled for even though certified highly qualified teachers were expected to be assigned to teach intervention classes. The low number of participating districts and schools were also a limitation which led to a very small number of cases for online only interventions. The researcher accepted all data provided as accurate and factual.

Despite these limitations, much will be learned from this study. Findings from this study intend to provide evidence to school administrators and teachers regarding intervention delivery methods and their possible impact on achievement of Kentucky's three college readiness assessments. Furthermore, the findings from this study intend to guide district and school policy makers to design and execute policies to efficiently and effectively leverage resources for a successful intervention system leading to an increase in college readiness graduation rates.

CHAPTER 4: FINDINGS

The purpose of this study was to determine if there was an association between achievement on Kentucky's college readiness assessments and the accelerated learning intervention delivery methods provided to twelfth grade underprepared students in mathematics.

The study was carried out with the assumptions that only highly qualified teachers delivered interventions, curriculum was aligned to state approved standards, a full class period was used for intervention daily, and that blended learning was delivered with a 70/30 to 60/40 instructional method time split using accelerated learning processes. The results in this chapter are organized by the research questions of this study.

Q1: What is the association between achievement on the ACT college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

Q2: What is the association between achievement on the COMPASS college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

Q3: What is the association between achievement on the KYOTE college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

Q4: What is the association between achievement on any of Kentucky's college readiness assessments and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

This study used existing student level data warehoused by the schools and districts for the class of 2015. After contact with participating districts superintendents, a designee was appointed to extract and provide needed data files from each district data base to the researcher. The researcher used this designee as a point of contact to inquire about missing data elements or issues with data files. The eleventh grade ACT assessment results were used solely to determine college readiness status as student entered their final year of high school. Also used in this study were the scale super scores for ACT, COMPASS and/or KYOTE assessments that students may have taken during their twelfth grade year. Scale super scores are recorded as the highest score achieved in any and all assessment retakes for each student. The intervention data focus element consisted of the delivery method of the intervention being face-to-face tutoring only, online/digital tutoring only, or blended learning tutoring.

Due to the same students taking multiple types of college ready assessments, overlap in many of the student cases among the different assessments may occur. The type of intervention for each student case remains constant regardless of the types of assessments administered to the student.

Twelfth Grade ACT Results

Q1: What is the association between achievement on the ACT college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

To test for an association between the ACT college readiness assessment results and accelerated learning intervention delivery methods, the twelfth grade ACT scale super score data were used in descriptive statistics and Chi Square analyses. By the end of the 2014-2015 school year, a final ACT scale super score is entered for each graduate. If the underprepared student did not retake the ACT during his/her twelfth grade year, the scale super score would be the same score as the eleventh grade administration score. If the student did retake the ACT, it would be the highest score achieved on any retakes. For the sample of 795 students who did not meet college readiness during the eleventh grade administration, 766 had super scores recorded in the data file. Within this sample of scores, the minimum score was ten and the maximum score was thirty-three. The mean score was 16.42 with a standard deviation of 2.224.

The data were provided by four districts in Central and Eastern Kentucky. The district names were replaced by numbers for reporting the results. Descriptive statistics were used to measure the mean scale super scores and standard deviation for each district. Table 4.1 represents the mean super scale scores, N counts and standard deviation for each participating district.

Table 4.1

ACT Math Super Scale Score Descriptives

District	Mean	N	Std. Deviation
District 1	17.67	89	4.405
District 2	16.04	330	1.343

Table 4.1 Continued

District	Mean	N	Std. Deviation
District 3	16.40	302	1.792
District 4	16.89	45	2.690

Intervention tutoring in the participating districts were delivered face-to-face, online/digital only, and blended learning. As shown in Table 4.2, 477 students received face-to-face tutoring, 43 students received online/digital tutoring and 245 received blended learning tutoring. Blended learning tutoring resulted in the highest mean scale super score and the highest standard deviation in scores.

Table 4.2

ACT Math Super Scale Score by Delivery Method

Delivery Method	Mean	N	Std. Deviation
Face-to-Face Tutoring Only	16.28	477	1.548
Online/Digital Tutoring Only	15.30	43	1.846
Blended Learning Tutoring	16.90	245	3.120

Based on the CPE benchmark college readiness scale score of 19 on the ACT mathematics subtest, college readiness achievement status has been calculated in Table 4.3. On the ACT assessment, 11.8% of the students who were provided blended learning tutoring achieved benchmark as compared to 3.1% of those in face-to-face tutoring and 2.3% of those students in online/digital only tutoring. Twice the students received face-to-face only tutoring than blended tutoring, yet blended learning tutoring yielded twice the number of students achieving mathematics benchmark on the ACT assessment.

Table 4.3

College Readiness Achievement on ACT by Delivery Method

Met Benchmark on ACT Math		F2F	Online/Digital	Blended	Total
No	Count	462	42	216	720
	% within Delivery Method	96.9%	97.7%	88.2%	94.1%
Yes	Count	15	1	29	45
	% within Delivery Method	3.1%	2.3%	11.8%	5.9%
Total	Count	477	43	245	765
	% within Delivery Method	100.0%	100.0%	100.0%	100.0%

Totals from Table 4.3 show that of the 765 students 720 did not meet CPE benchmark on the math ACT subtest and 45 students did meet benchmark after participating in an intervention.

A Chi-Square Fisher's Exact Test was run on the nominal variables ACT and delivery method which found a value of 20.610 with an exact significance of .000 which is less than the alpha of .05. Therefore, the null hypothesis was rejected because the association between college readiness achievement on the ACT assessment and intervention delivery method was significant.

Twelfth Grade COMPASS Results

Q2: What is the association between achievement on the COMPASS college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

To test for an association between the COMPASS college readiness assessment results and accelerated learning intervention delivery method the twelfth grade COMPASS scale super score data were used in descriptive statistics and Chi Square analyses. By the end of the 2014-2015 school year, a final COMPASS scale super score was entered for each graduate. There were 421 students in this data set who took the COMPASS assessment in attempts of achieving the CPE benchmark score of 36 on one administration or a subsequent if benchmark was not met on the first attempt. For the set of scale super scores on the 2014-2015 administration of COMPASS, the minimum score was fifteen and the maximum score was ninety. The mean score was 32.87 with a standard deviation of 12.790.

For COMPASS results, once again the district names were replaced by numbers for reporting the results. Descriptive statistics were used to measure the mean scale super scores and standard deviation for each district. Table 4.4 represents the mean super scale scores, N counts and standard deviation for each participating district.

Table 4.4

COMPASS Math Super Scale Score Descriptives

District	Mean	N	Std. Deviation
District 1	33.52	62	8.659
District 2	27.98	196	7.944
District 3	41.16	127	16.193
District 4	29.11	36	11.764

Intervention tutoring in the participating districts were delivered face-to-face, online/digital only, and blended learning. As shown in Table 4.5, 229 students received face-to-face tutoring, 13 students received online/digital tutoring and 179 received blended learning tutoring. Blended learning tutoring resulted in a mean scale super score 8.33 points higher than face-to-face tutoring and 12.32 points higher than online/digital tutoring only. While the mean score for blended learning tutoring was higher, so was the standard deviation.

Table 4.5

COMPASS Math Super Scale Score by Delivery Method

Delivery Method	Mean	N	Std. Deviation
Face-to-Face Tutoring Only	29.45	229	8.499
Online/Digital Tutoring Only	25.46	13	4.684
Blended Learning Tutoring	37.78	179	15.768

Based on the CPE benchmark college readiness score of a 36 on the COMPASS mathematics test, college readiness achievement status has been calculated in Table 4.6. On the COMPASS assessment, 40.8% of the students who were provided blended learning tutoring achieved benchmark as compared to 21.4% of those in face-to-face tutoring and 0.0% of those students in online/digital only tutoring. The percent of students who received face-to-face only tutoring and blended tutoring were fairly closely matched with 58 more students in the face-to-face intervention. However, blended learning tutoring once again yielded over twice the percentage and number of students achieving mathematics benchmark on the COMPASS assessment.

Table 4.6

College Readiness Achievement on COMPASS by Delivery Method

Met Benchmark on ACT Math		F2F	Online/Digital	Blended	Total
No	Count	180	13	122	315
	% within Delivery Method	78.6%	100.0%	59.2%	70.3%
Yes	Count	49	0	84	133

Table 4.6 Continued

Met Benchmark on ACT Math		F2F	Online/Digital	Blended	Total
	% within Delivery Method	21.4%	0.0%	40.8%	29.7%
Total	Count	229	13	206	448
	% within Delivery Method	100.0%	100.0%	100.0%	100.0%

Source: Council on Postsecondary Education. (2012). Senate Bill 1. Retrieved from http://cpe.ky.gov/

Totals from Table 4.6 show that 315 of the 448 students did not meet CPE benchmark on the math COMPASS test and 133 students did meet benchmark after participating in an intervention.

A Chi-Square Fisher's Exact Test was run on the nominal variables COMPASS achievement and delivery method which found a value of 25.731 with an exact significance of .000 which is less than the alpha of .05. Therefore, the null hypothesis was rejected because the association between college readiness achievement on the COMPASS assessment and intervention delivery method was significant.

Twelfth Grade KYOTE Results

Q3: What is the association between achievement on the KYOTE college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

To test for an association between the KYOTE college readiness assessment results and accelerated learning intervention delivery methods, the twelfth grade KYOTE scale super score data were used in descriptive and Chi Square analyses. By the end of the 2014-2015 school year, a final KYOTE scale super score was entered for each graduate. There were 419 students in this data set who took the KYOTE assessment in attempts of achieving the CPE benchmark score of 22 on one administration or subsequent administrations only if benchmark was not met on the first attempt. For the set of scale super scores on the 2014-2015 administration of KYOTE, the minimum score was one and the maximum score was thirty-one. The mean score was 17.64 with a standard deviation of 5.958.

For KYOTE results, once again the district names were replaced by numbers for reporting the results. Descriptive statistics were used to measure the mean scale super scores and standard deviation for each district. Table 4.7 represents the mean super scale scores, N counts and standard deviation for each participating district.

Table 4.7

<u>KYOTE Math Super Scale Score Descriptives</u>

District	Mean	N	Std. Deviation
District 1	18.60	89	5.154
District 2	14.63	172	5.317
District 3	20.39	158	5.551
District 4*	---	---	---

** No KYOTE scores available for District 4*

Intervention tutoring in the participating districts was delivered face-to-face, online/digital only, and blended learning. As shown in Table 4.8, 294 students received face-to-face tutoring, 16 students received online/digital tutoring and 109 received blended learning tutoring. Blended learning tutoring resulted in a mean scale super score

0.71 points higher than face-to-face tutoring and 5.15 points higher than online/digital tutoring only. While the mean score for blended learning tutoring was higher, the standard deviation was less than other two methods.

Table 4.8

KYOTE Math Super Scale Score by Delivery Method

Delivery Method	Mean	N	Std. Deviation
Face-to-Face Tutoring Only	17.63	294	6.066
Online/Digital Tutoring Only	13.19	16	6.442
Blended Learning Tutoring	18.34	109	5.323

Based on the CPE benchmark college readiness score of a 22 on the KYOTE mathematics test, college readiness achievement status has been calculated in Table 4.9. On the KYOTE assessment, 34.9% of the students who were provided blended learning tutoring achieved benchmark as compared to 34.04% of those in face-to-face tutoring and 18.8% of those students in online/digital only tutoring. There were 185 more students who received face-to-face only tutoring than blended tutoring. Blended learning tutoring yielded almost the same percentage of students achieving mathematics benchmark on the KYOTE assessment.

Table 4.9

College Readiness Achievement on KYOTE by Delivery Method

Met Benchmark on ACT Math		Face-to-Face	Online/Digital	Blended	Total
No	Count	194	13	71	278
	% within Delivery Method	66.0%	81.3%	65.1%	66.3%
Yes	Count	100	3	38	141
	% within Delivery Method	34.0%	18.8%	34.9%	33.7%

Table 4.9 Continued

Met Benchmark on ACT Math		Face-to-Face	Online/Digital	Blended	Total
Total	Count	294	16	109	419
	% within Delivery Method	100.0%	100.0%	100.0%	100.0%

Totals from Table 4.9 show that of the 419 students 278 did not meet CPE benchmark on the math KYOTE test and 141 students did meet benchmark after participating in an intervention.

A Chi-Square Fisher's Exact Test was run on the nominal variables KYOTE achievement and delivery method which found a value of 1.551 with an exact significance of .474 which is greater than the alpha of .05. Therefore, the null hypothesis was not rejected because the association between college readiness achievement on the KYOTE assessment and intervention delivery method was not significant.

As stated earlier, each school and district has the freedom to select the curriculum, materials, and instructional methods for providing interventions to the underprepared students. This is evident in Table 3.2 that shows how the schools and districts provided mathematics interventions to their underprepared students. Districts 1 and 4 provided blended learning tutoring to 100% of their underprepared students. District 2 provided the majority of their underprepared students face-to-face tutoring. District 3 provided more evenly distributed provisions of interventions with face-to-face still being the intervention provided to the majority of students and just under half of the students being provided either online/digital tutoring or blended learning tutoring.

Even though the attention drawn to the data in the previous chapter in Table 3.2 were not to compare districts against each other, the distribution simply shows that two districts (2 and 3) relied heavily on face-to-face tutoring while two districts (1 and 4) provided only blended learning tutoring to all underprepared twelfth grade students.

Q4: What is the association between achievement on any of Kentucky's college readiness assessments and the accelerated learning intervention delivery method in which underprepared twelfth grade students were provided during their twelfth grade year: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

Table 4.10 represents the percentage of students who attained college readiness status on any of the three Kentucky college readiness assessments. Of the three intervention methods, face-to-face is the delivery method provided to 61% of the underprepared students. Blended learning is provided to 32% of the students in the sample whereas 7% received only online/digital tutoring interventions. While 486 students received face-to-face tutoring, 149 of them achieved college readiness on any assessment. Of the 52 students who received online/digital learning, 4 of those students achieved college readiness status. Based on a conversation with district designees, online only students are usually enrolled in an alternative setting which placement is usually based on behavior and not academic potential. Blended learning was provided to 256 students of which 132 achieved college readiness. Overall 35.9% of the 794 students achieved college readiness on any assessment. Blended learning tutoring was associated with the greatest success in achieving college readiness status on any assessment at 51.6% as compared to face-to-face at 30.7% and online/digital at 7.7%.

Table 4.10

College Readiness Achievement on ANY Assessment

Met Benchmark on ANY Assessment		Face-to-Face	Online/Digital	Blended	Total
No	Count	337	48	124	509
	% within Delivery Method	69.3%	92.3%	48.4%	64.1%
Yes	Count	149	4	132	285
	% within Delivery Method	30.7%	7.7%	51.6%	35.9%
Total	Count	486	52	256	794
	% within Delivery Method	100.0%	100.0%	100.0%	100.0%

Interventions Cost Benefit Analysis

Providing interventions to underprepared students is an additional burden on the school and district resources. Combining the data on number of students in each intervention, cost of each intervention per semester, and the success rate of each intervention, an estimated cost analysis is shown in Table 4.11. The overall effect size between delivery method and college readiness attainment is .24 which is a medium effect size. The cost calculations were based on the average teacher salaries in Kentucky and student to teacher contact hours of instruction, plus the average cost of the software used in the participating districts. Actual costs in each school or district will depend on the actual salary of each teacher providing interventions and the actual cost of the software chosen by each school or district. Accompanying the costs of each intervention delivery method are the college readiness student yield calculated by both percent and number. School budgets are already limited and knowing the success rate and the cost will provide leaders evidence to make informed decisions.

Table 4.11

Intervention Cost Benefit Analysis

Delivery Method	Cost	# of Students	Total Cost	% College Ready	# College Ready
Face-to-Face (30:1)	117.00	486	39,429.00	30.7	149
Online/Digital (30)	15.50	52	744.00	7.7	4
Blended (30:1)	55.98	256	6,941.52	51.6	132

Note: Cost benefit analysis is per student per semester per contact hour

Summary

The findings of this study showed that there was a significant association between the achievement on two out of three of the college readiness assessments and the delivery method of the college readiness interventions provided to underprepared mathematics students. Statistical significance was evident for delivery method for both the ACT and COMPASS assessments while no statistical significance was found for the KYOTE. An even closer examination, showed that blended learning tutoring was associated with the highest mean scores and greatest number of students achieving college readiness achievement on each of three of Kentucky’s college readiness assessments: ACT, COMPASS, and KYOTE.

CHAPTER 5: CONCLUSIONS AND DISCUSSION

This retrospective quantitative study was designed to determine the association between achievement on Kentucky's college readiness assessments and the intervention delivery method provided to the underprepared twelfth grade mathematics students in the class of 2015 in six Kentucky high schools within four districts.

When students entering their final year of high school are found not to be college ready based on college readiness assessment measures, intenive, cost efficient and highly effective methods for interventions are critical. Accelerated academic gains are necessary over the short period of time in the twelfth grade. The blended learning tutoring intervention delivery method was associated with the highest percentage of underprepared students achieving college readiness status on the ACT, COMPASS, and KYOTE college readiness assessments when compared to both face-to-face tutoring and online/digital learning only tutoring. The correlation between the three college readiness measures is weak meaning that students who score high on one assessment may not necessarily score high on the others. This was to be expected since the three assessments were originally created with different purposes. COMPASS has recently been declared ineffective at measuring college readiness and now eliminated from current college readiness assessment opportunities for Kentucky students ACT (2010a). Further findings in this study exposed that the largest percentage of students achieved college readiness status using the KYOTE, with COMPASS coming in second and ACT last. Regardless of which test was associated with the greatest percentage of students achieving college readiness status, blended learning was associated with the greatest percentage of success on all three assessments.

This chapter will be divided into the following sections: (1) a discussion of the findings regarding the association between achievement on each of Kentucky's three college readiness assessments and the delivery method of the accelerated learning interventions provided to twelfth grade underprepared mathematics students; and (2) implications for leadership practices and educational policy; (3) recommendations for leadership practices and educational policies at the school, local and state level; (4) researcher assumptions, (5) limitations, and (6), future research.

Discussion of Research Question 1

Q1: What is the association between achievement on the ACT college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

ACT was discovered to be the least utilized of the three college readiness assessments in the four districts participating in this study. Even though the ACT was the least utilized of the three college readiness assessments in the four participating districts, blended learning was associated with four times the percentage of students achieving college readiness benchmark on the mathematics subtest compared to the other intervention delivery methods. Additionally, blended learning was associated with the highest mean scale scores when compared to the other delivery methods.

Discussion of Research Question 2

Q2: What is the association between achievement on the COMPASS college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

COMPASS was discovered to be the second most utilized of the three college readiness assessments in the four districts participating in this study. COMPASS is no longer available as a college readiness assessment. Again, blended learning was associated with twice the percentage of students achieving college readiness benchmark on the COMPASS mathematics test when compared to the other intervention delivery methods. Additionally, blended learning was associated with the highest mean scale scores when compared to the other delivery methods.

Discussion of Research Question 3

Q3: What is the association between achievement on the KYOTE college readiness assessment and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

KYOTE was revealed to be the most utilized of the three college readiness assessments in the four districts participating in this study. This discrepancy looks worse than it is because the students are struggling by the time they take the KYOTE. With more free opportunities to take KYOTE than COMPASS, it is usually a last chance assessment opportunity to achieve college readiness. The first ACT retake is free but costly afterwards and involves almost four hours of testing time as compared to COMPASS and KYOTE's free opportunities involving less than an hour of testing time just for mathematics.

Blended learning tutoring was associated with a higher mean scale score over both face-to-face tutoring and online/digital learning tutoring. While blended learning may have produced a higher mean scale score, the percentage of students achieving college readiness status was only 0.1% higher than face-to-face.

Discussion of Research Question 4

Q4: What is the association between achievement on any of the college readiness assessments and the accelerated learning intervention delivery method that was provided to 795 twelfth grade students in the class of 2015: (1) face-to-face tutoring only, (2) online tutoring only, and (3) blended learning tutoring?

Face-to-face tutoring was provided to the majority (61%) of the underprepared twelfth grade mathematics students but only 30.7% of those students achieved college readiness status in mathematics. Online/digital learning was the least ranked choice (7%) as an intervention delivery method and associated with the least college readiness achievement (7.7%) on any assessment. Blended learning tutoring was provided to almost one-third (30.7%) of the underprepared students but was associated with the greatest college readiness achievement with 51.6% of those students meeting or exceeding benchmarks in mathematics.

Implications

Kentucky uses the ACT as the initial measure of record to determine early college readiness in the eleventh grade. Kentucky high schools use these scores as qualifiers for transitional courses or intervention placement for twelfth grade students at the beginning of their twelfth grade year. KDE and CPE collaborated to set college readiness benchmarks unique to Kentucky which are markedly lower than the recommended national benchmarks based on empirical research by ACT. Specific to this study, the CPE benchmark is a scale score of 19 as compared to the national scale score of 22 recommended by ACT. While the mathematics ACT score of 19 is sufficient for enrollment into any basic college mathematics course in Kentucky, it is not sufficient for enrollment in the higher mathematics courses that may be needed for specific programs. In spite of the collaboration between CPE and KDE to establish College Readiness Benchmarks, in some cases Kentucky's college readiness benchmarks are not high enough for acceptance into many colleges and do not meet the minimum requirements for athletes to play college sports.

When twelfth grade students do not meet the CPE college readiness benchmarks on the ACT, they have the opportunity for additional opportunities using both the COMPASS and KYOTE college readiness assessments. Kentucky colleges have agreed to accept these scores as course placement indicators, however, they do not accept them in lieu of the ACT required score for college acceptance or athletic eligibility. There is a weak correlation among the three assessments with ACT more accurately indicating college readiness. While ACT has been proven to be the most accurate assessments, it is the most difficult, complicated, expensive, and least utilized of the three assessments for attaining college readiness status (Conn, L., 2013; Timmel, K., et. al., 2014). KYOTE is the most utilized assessment for indicating college readiness. Reason being for this is that it is free, online, extremely accessible and schools have autonomy in scheduling retakes. The findings in Chapter 4 showed that the type of assessment does matter. Using the KYOTE appeared to increase the odds for achieving college readiness over both COMPASS and ACT. Figure 5.1 represents the proportion of mathematics college readiness status attainment by assessment type. As summarized from chapter four: 5.9% met CPE college readiness mathematics benchmark via the ACT; 29.7% met benchmark via COMPASS; and 33.7% met benchmark via KYOTE; leaving 30.7% to not meet benchmark on any assessment.

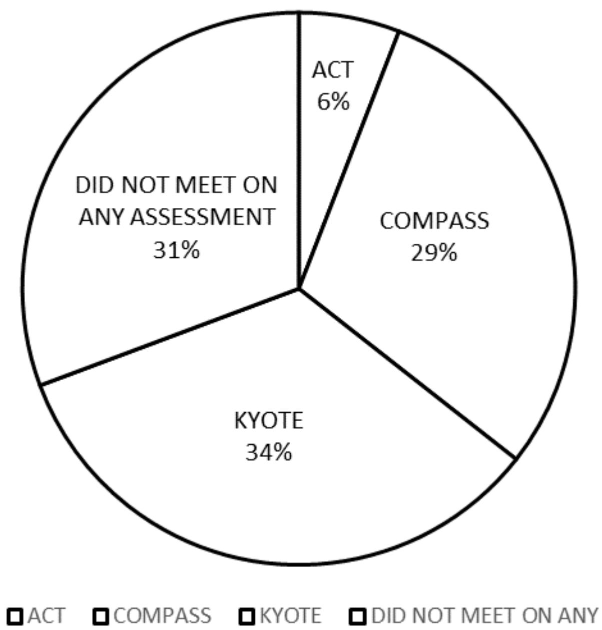

Figure 5.1. Percent College Ready by Assessment Type.

With COMPASS presently removed as a college readiness measure, this leaves schools to use only ACT and KYOTE as college readiness measures, thus reducing the number of opportunities available for students to achieve college readiness. If trends sustain, this means that almost 30% of underprepared high school students who could only achieve college readiness on COMPASS will now have to rely on one of the other college readiness assessments. Again, since the assessment correlations are weak, it is possible that these students may not achieve benchmark on the other assessments.

Regardless of the performance of underprepared students on each type of college readiness assessment, the intervention method for attaining college readiness status is blended learning tutoring. Based on the 51.6% success rate of blended learning tutoring as compared to face-to-face tutoring or online/digital learning tutoring only, if all students were provided blended learning, it is plausible that 410 of the 795 underprepared students could have achieved college readiness instead of the actual 285 students

Recommendations for Leadership Practices: Use of Assessments

Recommendations for leadership practices at the school level include intentional awareness practices for students regarding the importance of ACT scores not only for course placement and being a college readiness accountability statistic, but for acceptance into colleges of their choice, eligibility for playing college sports, and possibly even scholarships for high ACT scores. At the district level, college readiness standards could be included into district curriculum maps to align with college readiness criteria of colleges and college readiness assessments. At the state level, possibly weighting the accountability of ACT and future college readiness assessments based on a combination of college readiness standards designed by state accountability office. More resources could be allocated to fund a statewide administration of the ACT for all students who participated in interventions. This would provide additional measures for accountability, growth, effectiveness of interventions, and increase opportunities for higher ACT scores for college enrollment. If ACT offered its subtests as stand-alone tests, the utilization of the ACT would increase as well.

Recommendations for Leadership Practices: Interventions

Recommendations for leadership practices for college readiness interventions at the school level is probably the most critical due to direct impact on the underprepared students. Leadership practices could include professional learning for all intervention staff on accelerated learning, cognitive load combined with research-based tutoring practices. Also, provide professional learning opportunities on effective implementation of digital and blended learning for individualization and personalization of learning opportunities. School leaders should leverage staff instructional assignments and the school master schedule to strategically place highly effective and certified mathematics teachers with digital learning skills in dedicated intervention class periods.

It is critical for educational leaders to use sound research to make decisions when selecting mathematics tutoring software that meets the needs of each student. Be cautious of vendor produced or sponsored research that could be skewed to increase sales. Also from the ninth grade year, ensure that students are placed by needs in a mathematics course pipeline that will lead to college readiness. This is not a recommendation for tracking, but an individualized, personalized and adaptive fluid path for students to move through the mathematics course pipeline. School Based Decision Making (SBDM) committees and council could create student placement policies to address mathematics course placement for each student. School leaders should use data for student placement, progress monitoring and measuring college readiness whether it be in an informal spreadsheet or a formal database. Using this student data should be the focus of regularly occurring college readiness Professional Learning Communities dedicated to monitor the enrollment, progress, assessment retakes, and college readiness status of each student.

At the district level, leaders could leverage staff allocation to allow for extra staff, instructional technologies and programs at schools to serve underprepared students in a manner that is equitable to all underprepared students. This could be a trickle down from the leveraging of state funding for additional staff, instructional technologies and programs for schools to serve underprepared students. The state should continue to provide additional digital and blended learning guidance to schools for their underprepared students by providing a list of research-based digital learning programs designed for accelerated learning and intelligent tutoring. Also, continuing the implementation of the Intervention Tab for underprepared twelfth grade students will provide structure for accountability and data for making decisions on successful and unsuccessful intervention methods.

Recommendations for Education Policy

Recommendations for school level education policy consists of utilizing the purview of the SBDM to adopt curriculum that contains both the state approved standards and the college readiness standards for each mathematics course. Also, utilizing budget approvals to allow for adequate emerging educational instructional technologies, software and hardware leading to increased equitable access to blended learning opportunities. Recommendations for the district level include the development of intervention policy that supports the state regulations for college readiness interventions. More specifically, the district should design and implement guidelines for online/digital course enrollments and application of course credits. At the state level, digital learning policies should be formulated to increase access to digital learning resources that ensures high quality learning content that meets or exceeds state approved standards. This digital learning content must be adaptive, personalized and provide individualized elements to meet the individual learning needs to each student delivered by highly effective teachers. All vendors and course providers must be accredited institutions or provide evidence that all digital learning content is congruent to state approved standards and instructional digital learning practices.

Limitations

The limitations recognized in this study were that the researcher did not control for student socioeconomic background, duration of the intervention, teacher quality of the intervention, low number of participating districts and schools, and no control for the number of test administrations per student. First, the researcher did not control for student socioeconomic background due to district interpretation of federal limitations on the release of this type of student data. Two districts allowed the release of this data to the researcher while two districts did not due to local policies. The duration of the interventions varied greatly by student because the students were enrolled in a mathematics intervention until the students met benchmark on one of the college readiness assessments. Again, two districts provided this data while two did not. Teacher quality for the intervention was not controlled for even though certified highly qualified teachers were expected to be assigned to teach intervention classes. The low number of participating districts and schools were also a limitation which led to a very small number of cases for online only interventions. The researcher accepted all data provided as accurate and factual.

Despite these limitations, much could be learned from this study. Findings from this study intend to provide evidence to school administrators and teachers regarding intervention delivery methods and their possible impact on achievement on Kentucky's three college readiness assessments. Furthermore, the findings from this study intend to guide district and school policy makers to design and execute policies to efficiently and effectively leverage resources for a successful intervention system leading to an increase in college readiness graduation rates.

The correlations between the three college readiness assessments are low, with the Pearson's r value for ACT and COMPASS being .353; ACT and KYOTE being .314; and COMPASS and KYOTE being .259. This supports the interpretation that students who score relatively higher on one assessment do not necessarily score high on others. It is likely that the three college readiness assessments do not measure the same content, skills or similar constructs of college readiness in mathematics.

Implications for Future Study

Student background, intervention duration, teacher quality, low number of districts, low number of cases representing online/digital tutoring only delivery method, and no uniform number of test administrations for each of the assessments all inform suggestions for future studies.

Another future study should include an analysis of the type of software used in both online/digital learning and blended learning tutoring to see which types of software make the greatest impact on college readiness achievement. Additionally, a study should be conducted to examine whether there is a difference in the impact of intervention delivery methods on each of the gap group students.

Conclusion

Blended Learning tutoring was associated with the greatest achievement on all three of Kentucky's college readiness assessments, therefore blended learning interventions should be provided to all underprepared twelfth grade students to increase the attainment of college readiness status. Blended learning requires equitable access to adequate technologies and educator capacity for implementation. Education leaders should leverage all human, time, and fiscal resources to provide equitable access for all students. Policy makers and educational governing bodies should design and develop state and national policies to direct funds and guide aligned acts of improvement necessary for college readiness for all students.

REFERENCES

13 KAR 2:020. (n.d.) *Guidelines for admission to the state-supported postsecondary education institutions in Kentucky*. Retrieved from http://www.lrc.ky.gov/kar/013/002/020.htm

704 KAR 3:305. (2016). *Minimum requirements for high school graduation*. Retrieved from http://www.lrc.ky.gov/kar/704/003/305.htm

Accelerated Learning. (2011, April 14). Retrieved from http://www.funderstanding.com/educators/accelerated-learning/

Acree, L., & Fox, C. (2015, May). *State digital learning exemplars: Highlights from states leading change through policies and funding*. Friday Institute for Educational Innovation at the NC State University College of Education and the State Educational Technology Directors Association. Retrieved from http://www.setda.org/wp-content/uploads/2015/10/DigitalLearningExemplars_June2015.pdf

ACT (2010a). *Concordant ACT, COMPASS, and ASSET Scores*.

ACT (2010b). *The Alignment of Common Core and ACT's College and Career Readiness System*.

ACT (2015). *The condition of college & career readiness 2015*. Retrieved from http://www.act.org/content/dam/act/unsecured/documents/Condition-of-College-and-Career-Readiness-Report-2015-United-States.pdf

ACT (2016). *Getting ready*. Retrieved from http://www.act.org/content/act/en/products-and-services/the-act/taking-the-test.html

ACT (2016). *Test information and descriptions: Improving student outcomes with quality assessment data*. Retrieved from http://www.act.org/content/act/en/products-and-services/act-compass/about-act-compass.html

Al-Qahtani, A. A., & Higgins, S. (2013). Effects of traditional, blended and e-learning on students' achievement in higher education. *Journal Of Computer Assisted Learning*, *29*(3), 220-234. doi:10.1111/j.1365-2729.2012.00490.

Amos, J. (2010). Help wanted: Projections of job and education requirement through 2018. *Straight A's: Public Education Policy and Progress*, *10*(13), 1-12.

Arkansas Digital Learning Act, 1280, Ark. Assemb. B. 1785, 16 (Ark. Stat. 2013).

Autor, D., & Katz, L. (2010, September 27). *Grand challenges in the study of employment and technological change: A white paper prepared for the National Science Foundation* [White paper]. Retrieved from http://poseidon01.ssrn.com/delivery.php?ID=495104001002064116009072071016113081101069081061084031018005020028083093002113093101000003027026054116046000011021121030027094107048048080009069017114106084085025086039033000103118118119007103100071005126116113066099125013080106017075111127087117101&EXT=pdf

Bartelet, D., Ghysels, J., Groot, W., Haelermans, C., & Maassen van den Brink, H. (2016). The Differential Effect of Basic Mathematics Skills Homework via a Web- Based Intelligent Tutoring System Across Achievement Subgroups and Mathematics Domains: A Randomized Field Experiment. *Journal of Educational Psychology*, *108*(1), 1–20. http://doi.org/10.1037/edu0000051

Blayney, P., Kalyuga, S., & Sweller, J. (2015). Using cognitive load theory to tailor instruction to levels of accounting students' expertise. *Journal of Educational Technology & Society*, *18*(4), 199–210.

Bloom, B. S. (1984). The search for methods of group instruction as effective as one-to-one tutoring. *Educational Leadership*, *41*(8), 4.

Blume, G. H., & Zumeta, W. M. (2013). The State of State College Readiness Policies. *American Behavioral Scientist*, *58*(8), 1071.

Bonanno, K. (2000). SURVIVAL SKILLS. Retrieved from http://kb.com.au/content/uploads/2014/08/AcceleratedLearning.pdf

Botsios, S., Georgiou, D., & Safouris, N. (2008). Contributions to Adaptive Educational Hypermedia Systems via on-line Learning Style Estimation. *Educational Technology & Society*, *11*(2), 322–339.

Bregant, J. (2014). Boris Aberšek, Bojan Borstner. *Journal of Baltic Science Education*, *13*(3). Retrieved from http://oaji.net/articles/2015/987-1437062280.pdf

Bregant, J., Borstner, B., & Aberšek, B. (2014). THE VIRTUAL SCIENCE TEACHER AS A HYBRID SYSTEM: COGNITIVE SCIENCE HAND IN HAND WITH CYBERNETIC PEDAGOGY. *Journal of Baltic Science Education*, *13*(3). Retrieved from http://oaji.net/articles/2015/987-1437062280.pdf

Brown, R. S., & Conley, D. T. (2007). Comparing state high school assessments to standards for success in entry-level university courses. *Educational Assessment*, *12*(2), 137–160.

Cain, S. (2011, September). COLLEGE AND CAREER READINESS IN KENTUCKY: Senate Bill 1 for Board Orientation Book. Council for Post-Secondary Education.

Cain, S. (2012, November 2). College Readiness Indicator Document. KY Council for Postsecondary Education. Retrieved from http://cpe.ky.gov/policies/academicinit/deved/

Callan, P. M., Finney, J. E., Kirst, M. W., Usdan, M. D., & Venezia, A. (2006, March). *Claiming common ground: State policymaking for improving college readiness and success*. (Report No. 06-1). Retrieved from National Center for Public Policy and Higher Education: http://files.eric.ed.gov/fulltext/ED491187.pdf

Canfield, W. (2001). ALEKS: A WEB-BASED INTELLIGENT TUTORING SYSTEM. *Mathematics & Computer Education*, *35*(2), 152-158.

Carnevale, A. P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of job and education requirements through 2018*. Retrieved from Georgetown University, Center on Education and the Workforce: https://cew.georgetown.edu/wp-content/uploads/2014/12/HelpWanted.ExecutiveSummary.pdf

Center for Education Reform (2015). Top Digital Learning Policy Issues to Watch in 2015.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, *8*(4), 293–332.

Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational Research Review*, *9*, 88–113.

Clough, S., & Montgomery, S. (2015). *How ACT assessments align with state college and career readiness standards*. Retrieved from ACT:

https://www.act.org/content/dam/act/unsecured/documents/Alignment-White-Paper.pdf

College- and Career-Ready Standards. (n.d.). Retrieved from U.S. Department of Education: http://www.ed.gov/k-12reforms/standards

Combs, B. D. (2014). Kentucky's Digital Learning Guidelines 4.0. KY Department of Education.

Compare ACT Scores for Admission to Kentucky Colleges and Universities. (2016). Retrieved October 3, 2016, from http://collegeapps.about.com/od/state-act-scores/a/kentucky-act-scores.htm

Conley, D. T. (2007). *Toward a more comprehensive conception of college readiness*. Eugene, OR: Educational Policy Improvement Center.

Conn, L. (2013). *Alignment study of Kentucky's mathematics placement examinations and entry level credit-bearing mathematics course examinations* (Doctoral dissertation). Retrieved from http://ir.library.louisville.edu/cgi/viewcontent.cgi?article=1268&context=etd

Council on Postsecondary Education. (2012). Senate Bill 1. Retrieved from http://cpe.ky.gov/

Digital Learning. (2016). Retrieved from Alliance for Excellent Education: http://all4ed.org/issues/digital-learning/

Digital Learning Now. (2013). *2012 Digital Learning Report Card*. ExcelinEd.

Digital Learning Now. (2014). *2013 Digital Learning Report Card*. ExcelinEd.

Digital Learning Now. (2015). *2014 Digital Learning Report Card*. ExcelinEd.

Dolenc, K., Aberšek, B., & Aberšek, M. K. (2015). Online functional literacy, intelligent tutoring systems and science education. *Journal of Baltic Science Education*, *14*(2), 162–171.

Dolenc, K., & Aberšek, B. (2015). TECH8 intelligent and adaptive e-learning system: Integration into Technology and Science classrooms in lower secondary schools. *Computers & Education*, *82*, 354–365. http://doi.org/10.1016/j.compedu.2014.12.010

Eakin, P. (2016). *KYOTE Training - The Policies*.

Edgecombe, N. (2011, February). *Accelerating the academic achievement of students referred to developmental education*. (Working Paper No. 30). Retrieved from Community College Research Center, Columbia University: http://eric.ed.gov/?id=ED516782

Educational Policy Improvement Center (EPIC). (2007, March). Toward a more comprehensive conception of college readiness. Retrieved from http://www.cisga.org/cisgawpress/wp-content/uploads/2013/07/Conley-report-full-version.pdf

Effective Strategies for Accelerated Learning: Hearing before the Committee on Health, Education, Labor, and Pensions, Senate, 112th Cong. 1.

Every Student Succeeds Act of 2015, 20 U.S.C. §§ 114-95 (2015).

Forum Guide to College and Career Ready Data. (2015) National Forum on Educational Statistics. Retrieved July 6, 2016, from https://nces.ed.gov/programs/statereform/tab5_9.asp

Friedman, T., & Mandelbaum, M. (2011). *That Used To Be Us: What Went Wrong with America - and How It Can Come Back* (1st ed.). Picador.

Gecer, A., & Dag, F. (2012). A blended learning experience. *Educational Sciences: Theory and Practice*, *12*(1), 438–442.

Hamon, S. (2012). Kentucky System of Intervention Response to Intervention Guidance Document Version 2.1. Kentucky Department of Education.

Holliday, D. T. (2014). Using intervention strategies to boost student success | Kentucky Teacher. Retrieved from http://www.kentuckyteacher.org/leadership/commissioners-comments/2014/03/using-intervention-strategies-to-boost-student-success/

Hrubik-Vulanovic, T. (2013, August). *Effects of intelligent tutoring systems in basic algebra courses on subsequent mathematics lecture courses* (Doctoral dissertation). Kent State University, Kent, OH. Retrieved from https://etd.ohiolink.edu/!etd.send_file?accession=kent1373337020&disposition=inline

Hurst, B. (2010, September). College and Career Readiness Unified Plan. Kentucky Department of Education.

Imel, S. (2002). *Accelerated learning in adult education and training and development.* Retrieved from http://files.eric.ed.gov/fulltext/ED462551.pdf

Innes, R. (2014, December 10). *Kentucky state researchers: Don't use college and career readiness rates as primary indicators*. Retrieved from Bluegrass Institute: http://www.bipps.org/kentucky-state-researchers-dont-use-college-career-readiness-rates-primary-indicators/

Jaggars, S. S., Hodara, M., Cho, S., & Xu, D. (2015). Three accelerated developmental education programs: Features, student outcomes, and implications. *Community College Review*, *43*(1), 3-26. doi:10.1177/0091552114551752

Kentucky Department of Education, *School Report Card*. (2016). *Data sets 2014-2015: Financial data*. Retrieved from http://applications.education.ky.gov/SRC/DataSets.aspx

Kentucky Department of Education (2015, November 10). *College/career readiness for all*. Retrieved from http://education.ky.gov/educational/CCR/Pages/default.aspx

Kentucky Department of Education (KDE). (2016). *Open house*. Retrieved from http://openhouse.education.ky.gov/

KDE School Report Card. (2015). Retrieved September 27, 2016, from http://applications.education.ky.gov/SRC/LearningEnvironmentByDistrict.aspx

Kentucky Council on Postsecondary Education. (2015). *College readiness and developmental education overview*. Retrieved from http://cpe.ky.gov/policies/academicinit/deved/

Kentucky Department of Education. (2015). *2015 Regular session of the Kentucky general assembly: Final enacted legislation*. Retrieved from http://education.ky.gov/CommOfEd/fri/Documents/2015%20RS%20Final%20Bills-FINAL05012015.pdf

Kentucky Department of Education. (2016). *2016 Regular session of the Kentucky general assembly: Final enacted legislation related to P-12 education*. Retrieved from http://education.ky.gov/CommOfEd/mon/Documents/2016%20RS%20Final%20 Bills-FINAL.pdf

KRS 158.6459. (2016, July 15). *Intervention strategies for accelerated learning: Individualized learning plan; Retake of college admissions examination*. Retrieved from http://www.lrc.ky.gov/statutes/statute.aspx?id=45402

KYOTE. (2012). *Practice placement exams*. Retrieved from https://www.kyote.org/mc/placementPractice.aspx

Li, Q., & Ma, X. (2010). A meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review*, *22*(3), 215–243. Retrieved from http://doi.org/10.1007/s10648-010-9125-8

Maier, M. P., Pate, J. L., Gibson, N. M., Hilgert, L., Hull, K., & Campbell, P. C. (2016). A quantitative examination of school leadership and response to intervention. *Learning Disabilities Research & Practice*, *31*(2), 103–112. Retrieve from http://doi.org/10.1111/ldrp.12100

Madison, B.L. (2001). Bumps in the road from school to college mathematics. *Focus, 1*(21), 10-11.

Mattern, K., & Lacina, C. (2015). *Different Assessments, Different Results: A Cautionary Note When Interpreting State Test Results* (Issue Brief). ACT.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43–52.

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, *115*(3), 1–47.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of Evidence-Based Practices in Online Learning A Meta-Analysis and Review of Online Learning Studies* (Evaluation) (pp. 1–94). Washington, DC.

Mokher, C. (2014, March). *Participation and pass rates for college preparatory transition courses in Kentucky*. Retrieved from http://files.eric.ed.gov/fulltext/ED544765.pdf

NAIA. (2016) *NAIA modifies ACT standards for initial eligibility*. Retrieved October 3, 2016, from http://www.naia.org/ViewArticle.dbml?ATCLID=210973024&DB_OEM_ID=27900

National Center for Academic Transformation (NCAT). (2006). *The emporium model: How to structure a Math Emporium—Advice from NCAT's redesign scholars*. Retrieved from http://www.thencat.org/R2R/AcadPrac/CM/MathEmpFAQ.htm

National Center for Education Statistics (NCES). (n.d.). *State education reforms (SER)*. Retrieved from https://nces.ed.gov/programs/statereform/tab5_9.asp

National Forum on Education Statistics. (2015, May). *Forum Guide to College and Career Ready Data*. Retrieved from http://nces.ed.gov/pubs2015/2015157.pdf

Noland, K. (2007, October 26). *Kentucky Department of Education and Council on Postsecondary Education: Collaborations to increase college readiness*. Retrieved from http://cpe.ky.gov/NR/rdonlyres/0B5C26DC-77C1-4CDF-B511-0A7B1B4CB00D/0/6_CommofEdreport.pdf

O’Brien, E., & Dervarics, C. (2012, March). *Is high school tough enough: Full report*. Retrieved from http://www.centerforpubliceducation.org/Main-Menu/Instruction/Is-high-school-tough-enough-At-a-glance/Is-high-school-tough-enough-Full-report.html

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, *38*(1), 1-4.

Pace, L., & Worthen, M. (2014, October). *Laying the foundation for competency education: A policy guide for the next generation educator workforce*. Retrieved from http://www.inacol.org/wp-content/uploads/2015/02/laying-foundation-competency-education-policy-guide.pdf

Pane, J. F., Steiner, E. D., Baird, M. D., & Hamilton, L. S. (2015). *Continued Progress*. Rand Corporation. Retrieved from http://www.k12accountability.org/resources/Blended-and-Adaptive-Learning/RAND_Personalized_Learning_Evidence.pdf

Patchan, M. M., Schunn, C. D., Sieg, W., & McLaughlin, D. (2016). The effect of blended instruction on accelerated learning. *Technology, Pedagogy and Education*, *25*(3), 269–286. Retrieved from http://doi.org/10.1080/1475939X.2015.1013977

Patrick, S., Kennedy, K., & Powell, A. (2013). *Mean what you say: Defining and integrating personalized, blended and competency education*. Retrieved from http://www.inacol.org/wp-content/uploads/2015/02/mean-what-you-say.pdf

Patrick, S., Worthen, M., Frost, D., & Gentz, S. (2016). *Promising State Policies for Personalized Learning*. Virginia: International Association for K-12 Online Learning.

Patterson, A. (2016). *Transitional Interventions: Preparing Students to Be College and Career Ready*. Kentucky Department of Education.

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.176.6811&rep=rep1&type=pdf

Pieper, A. (2014). KDE Intervention Tab Materials Code Reference Sheet.

Plass, J. L., Moreno, R., & Brünken, R. (Eds.). (2010). *Cognitive load theory*. New York, NY: Cambridge University Press.

Plunkett, J. (2016, January 14). *ESSA becomes law: What happened to college and career readiness?* Retrieved from https://www.hobsons.com/resources/entry/essa-becomes-law-what-happened-to-college-and-career-readiness

Russell, S. J., & Norvig, P. (1995). *Artificial intelligence: A modern approach*. Englewood Cliffs, N.J: Prentice Hall.

Serçe, F. C., Alpaslan, F. N., & Jain, L. C. (2008). Intelligent learning system for online learning. *International Journal of Hybrid Intelligent Systems*, *5*(3), 129-141.

Siemens, G. (2005, January). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, *2*(1). Retrieved from http://www.itdl.org/journal/jan_05/article01.htm

Slavin, R. E., Lake, C., & Groff, C. (2008, August). *Effective programs in middle and high school mathematics: A Best-Evidence synthesis*. Retrieved from http://www.bestevidence.org/word/mhs_math_Sep_8_2008.pdf

Staker, H., & Horn, M. (2011). *Classifying K-12 Blended learning* (p. 22). Innosight & Harvard Business School.

Stillson, H., & Nag, P. (n.d.). EDUCATION ALEKS AND MATHXL: USING ONLINE INTERACTIVE SYSTEMS TO ENHANCE A REMEDIAL ALGEBRA COURSE.

Superfine, B. M. (2011). Stimulating school reform: The American Recovery and Reinvestment Act and the shifting federal role in education. *Mo. L. Rev.*, *76*, 81.

Sweller, J. (2015). In academe, what is learned, and how is it learned? *Current Directions in Psychological Science*, *24*(3), 190–194.

Timmel, K., Hoppmann, G., Nelson, D., Alexander, A., Landy, B., & Olds, S. (2014). *A look inside Kentucky's college and career readiness data*. Retrieved from http://www.lrc.ky.gov/lrcpubs/RR410.pdf

U.S. Department of Education. (2010). *ESEA reauthorization: A blueprint for reform*. Retrieved from http://www2.ed.gov/policy/elsec/leg/blueprint/index.html

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46*(4), 197–221. http://doi.org/10.1080/00461520.2011.611369

Walkington, C. A. (2013). Using adaptive learning technologies to personalize instruction to student interests: The impact of relevant contexts on performance and learning outcomes. *Journal of Educational Psychology*, *105*(4), 932–945. http://doi.org/10.1037/a0031882

Wang, Y., Han, X., & Yang, J. (2015). Revisiting the blended learning literature: Using a complex adaptive systems framework. *Educational Technology & Society*, *18*(2), 380-393.

Yushau, B. (2006). The effects of blended e-learning on mathematics and computer attitudes in pre-calculus algebra. *The Mathematics Enthusiast*, *3*(2), 176-183.

Zinth, J., & Millard, M. (2015, March). *Using assessments to inform 12th-grade interventions and accelerations*. Retrieved from http://files.eric.ed.gov/fulltext/ED560996.pdf

APPENDIX A:

IRB Approval Letter

Graduate Education and Research
Division of Sponsored Programs
Institutional Review Board

EASTERN KENTUCKY UNIVERSITY
Serving Kentuckians Since 1906

Jones 414, Coates CPO 20
521 Lancaster Avenue
Richmond, Kentucky 40475-3102
(859) 622-3636; Fax (859) 622-6610

NOTICE OF IRB EXEMPTION STATUS

Protocol Number: 000223

Institutional Review Board IRB00002836, DHHS FWA00003332

Principal Investigator: **Barbara Spurlock** Faculty Advisor: **Dr. Charles Hausman**

Project Title: **Eleventh Hour Rally for College Readiness of Underprepared Twelfth Grade Students**

Exemption Date: **8/22/16**

Approved by: **Dr. Rachel Williams, IRB Member**

This document confirms that the Institutional Review Board (IRB) has granted exempt status for the above referenced research project as outlined in the application submitted for IRB review with an immediate effective date. Exempt status means that your research is exempt from further review for a period of three years from the original notification date if no changes are made to the original protocol. If you plan to continue the project beyond three years, you are required to reapply for exemption.

Principal Investigator Responsibilities: It is the responsibility of the principal investigator to ensure that all investigators and staff associated with this study meet the training requirements for conducting research involving human subjects and follow the approved protocol.

Adverse Events: Any adverse or unexpected events that occur in conjunction with this study must be reported to the IRB within ten calendar days of the occurrence.

Changes to Approved Research Protocol: If changes to the approved research protocol become necessary, a description of those changes must be submitted for IRB review and approval prior to implementation. If the changes result in a change in your project's exempt status, you will be required to submit an application for expedited or full IRB review. Changes include, but are not limited to, those involving study personnel, subjects, and procedures.

Other Provisions of Approval, if applicable: None

Please contact Sponsored Programs at 859-622-3636 or send email to tiffany.hamblin@eku.edu or lisa.royalty@eku.edu with questions.

APPENDIX B:

IRB Recruitment Letter

August 30, 2016

Dear High School Principal,

I am B. Darlene Spurlock, a doctoral student at Eastern Kentucky University. I am working on a study as a requirement for my doctorate degree to examine how KY schools are using interventions and transitional courses to achieve college readiness in English, mathematics and reading. I will examine the differences in college readiness super scores after participation in transitional courses or interventions. In particular, I will look at the delivery methods of transitional courses and interventions such as (1) face-to-face tutoring only, (2) online or computer assisted tutoring only, or (3) blended learning tutoring. High schools and districts were selected due to high data quality standards and willingness to volunteer to participate in my study.

I am asking if you would share your college readiness data without student names for the graduating class of 2015? I am already certified in student data confidentiality for both KDE and EKU. I will provide you a copy of this certificate plus an additional letter from me to you outlining specific measures I will use to maintain data confidentiality during analyses and communication of findings.

Like I said, earlier, I am studying several KY high schools and districts. I plan to put all students in the data base and then analyze them by prior achievement performance quartiles so individual school names will not be attached to my findings.

Are you interested in this collaboration? If so, please let me know and I will arrange to meet with you or email you with more details regarding the data files I need and confidentiality documents.

Respectfully,

Barbara Darlene Spurlock

EKU College of Education Adjunct Instructor
Department of Curriculum & Instruction
Office: Combs 113
Call or Text: 859-779-9902

APPENDIX C:

Kentucky Digital Learning Guidelines

Kentucky Digital Learning Guidelines

Digital Learning
Kentucky Department of Education

Introduction

The Kentucky Department of Education Digital Learning Team designed the **Kentucky Digital Learning Guidelines** as guidance for schools, districts, and digital providers when selecting or creating developmentally appropriate digital learning resources for instruction, as well as online and blended learning courses in Kentucky schools. These guidelines are timely due to schools providing 21st century learning opportunities for Kentucky students that are rigorous, differentiated, standard-based, and responsive to our increasing information rich, and rapidly expanding networked technological culture. Digital learning resources as well as online and digital learning courses used in Kentucky must align explicitly to the Kentucky approved academic standards appropriate for each course and be endorsed by a highly qualified content teacher. Best practices embedded within the delivery of digital learning resources as well as online and blended learning courses by a highly qualified content teacher should increase student engagement and achievement to close achievement gaps, and lead Kentucky's students to college and/or career readiness by graduation.

Digital Learning Guiding Principles

To ensure that digital learning resources, online courses and blended learning courses meet or exceed the criteria for high quality traditional instruction, these five Guiding Principles have been established:

- A highly qualified teacher in the school (and/or district) reviews and endorses digital content.
- A highly qualified teacher or content mentor stewards student learning performance and demonstrated mastery.
- Learners have access to highly qualified teachers, content coaches, or professionally recognized masters in the course field, as mentors in their digital learning experience.
- Student learning experiences are personalized based on the following: student's diagnostic data, learning style, and learning needs which allow for student choice, voice, and pace.
- Effective teaching practices prescribed by Professional Growth and Effectiveness System apply equally to digital learning experiences.

The Kentucky Digital Guidelines are an overview of best practices for digital and blended learning resources.
For more detailed guidance, clarification and specific criteria of high quality digital resources visit:
International Association for K-12 Online Learning
Quality Matters Digital Learning Now
NCAA
Last modified Tuesday, February 04, 2014

Kentucky Digital Learning Guidelines

By using these guidelines, districts and schools will confidently be able to offer high quality, standards-based digital course content coupled with effective digital pedagogy, including ongoing analysis of quality, effectiveness, and student-centered success. Providers of digital learning resources for instruction, as well as online and blended learning courses, will be able to conduct ongoing analysis of quality, effectiveness, and alignment to the **Kentucky Digital Learning Guidelines** to share with recipient districts and schools.

Content

- **Course content is aligned in scope and sequence to the Kentucky approved academic standards for each digital learning resource, online and blended learning course. When appropriate, these resources and courses align with Kentucky course descriptions and bear course code assignments established by 704 KAR 3:540.**
  - *Content may be obtained from a vendor, built by a highly qualified content teacher, or a combination of both.*
  - *Online or blended courses, not from an accredited or approved source, are reviewed by a local review committee(content specific highly qualified teacher, administrative designee, district technology coordinator designee and a curriculum/instructional coach if available) before enrolling students in the courses.*
  - *Basal textbooks (print or digital) follow state guidelines of review and notification as established in KRS 156.395-476 and 704 KAR 3:445. (Does not apply to supplemental.)*
- **A content appropriate, highly qualified teacher reviews and endorses all digital learning resources, online and blended course content.**

Digital Pedagogy

- **If an online course has been assigned to a highly qualified teacher, then a building level course steward may oversee the implementation of the course if provided within the school building.**
- **Teacher course stewards are trained in the delivery of online/blended learning embedding the principles of Characteristics of Highly Effective Teaching and Learning (CHETL) and the Professional Growth and Effectiveness System (PGES).**
- **Online courses have components that provide access to the course content anytime, anyplace and at the student's own pace.**
- **Students taking an online course or blended learning course have access to a highly qualified teacher or content mentor for two-way communication, collaboration, questions and/or tutoring.**

Technology Readiness

- **Schools implementing online/blended learning provide adequate facilities and tools to students and teacher in order to facilitate successful learning experiences (e.g., labs, stations, 1:1, BYOD, adequate wireless access, Learning Management System (LMS), etc).**
- **The development of digital citizenship skills for students and teachers prior to and during online or blended learning experience is an integral part of technology readiness.**

The Kentucky Digital Guidelines are an overview of best practices for digital and blended learning resources.
For more detailed guidance, clarification and specific criteria of high quality digital resources visit:
International Association for K-12 Online Learning
Quality Matters Digital Learning Now
NCAA
Last modified Tuesday, February 04, 2014

Kentucky Digital Learning Guidelines

Leadership and Governance

- **The local board of education and/or the school-based decision making (SBDM) council establishes appropriate school and district policies governing online course enrollment, parameters, course credits, etc.**
- **Course providers are accredited institutions approved by Kentucky-recognized accreditation organizations.**
- **Vendors of comprehensive online programs, course providers and digital learning resource vendors provide evidence that their products are congruent to Kentucky's course review criteria.**
- **School and district leadership coordinate academic programs, advising, and counseling to align with best practices.**
  - *When a personalized learning path is appropriate for student(s), schools and districts cooperate with other schools and districts to offer digital course experiences for programs available at one school, but not at another*
- **School and district leaders use data-driven processes to evaluate instructional delivery of programs using best practices**
  - *This includes data derived from assessments, observation data, student and teacher evaluations, and clinical performance data*
- **Principals and superintendents monitor faculty and staff performance to ensure quality digital learning instruction.**
  - *Teachers are certified in appropriate areas of instruction in Kentucky*
  - *Principals and superintendents provide opportunities for professional development and training for online and blended learning instruction as technology and digital pedagogy evolve*

Assessment System

- **Schools and districts regularly evaluate their assessment system to reflect college and career readiness goals for online and blended learning student proficiencies and gap reduction** (e.g. *assessment data points include comparison data of digital and non-digital student data, performance data, and gap data)*
- **Assessment systems for digital learning programs provide useful data and feedback loops that measure teacher effectiveness, student proficiencies, and program quality and include but are not limited to the following elements:**
  - *Observational evaluations (teacher, student, teacher supervisor, principal)*
  - *Test scores, performance-based assessments, project-based assessments, problem-based performance, etc.*
  - *Community-based needs assessments*
  - *Faculty meeting minutes, Professional Learning Community (PLC) minutes, student council data, public feedback*
  - *Feedback loop to address personalization of learning path, remediation, acceleration, school improvement planning, Response to Intervention (RtI), and planning*

The Kentucky Digital Guidelines are an overview of best practices for digital and blended learning resources.
For more detailed guidance, clarification and specific criteria of high quality digital resources visit:
International Association for K-12 Online Learning
Quality Matters Digital Learning Now
NCAA
Last modified Tuesday, February 04, 2014

Kentucky Digital Learning Guidelines

- **Systematic review of performance data is used to develop school and district improvement plans.**

Continuous Improvement Planning

- **Schools and districts regularly assess alignment of goals for digital learning benchmarks.**
  - *Improve retention and success in online and developmental education.*
  - *Set reasonable benchmarks for success that lead to college and/or career readiness requirements.*
  - *Review processes, systems, and instructional strategies to ensure efficient, effective operations and strategic thinking.*
  - *Make data-driven decisions across the district.*
  - *Provide students with feedback and support in a manner that is understandable and actionable by the student(s).*
- **Schools and districts emphasize differentiated professional learning for continuous improvement of professional skills. This professional learning is specific to online and blended learning courses by discipline.**
- **Schools and districts maintain evidence of parent and community engagement (e.g., log of contacts, signed agreements, parent conference logs, policies, the handbook, parent involvement on the SBDM council, and website).**
- **Schools and districts maintain evidence of a process to monitor the progress of gap students as identified by the Kentucky Department of Education (students with disabilities, English language learners, minority students and students on free or reduced lunch) and have systems in place to address the needs of diverse learners.**

The Kentucky Digital Guidelines are an overview of best practices for digital and blended learning resources.
For more detailed guidance, clarification and specific criteria of high quality digital resources visit:
International Association for K-12 Online Learning
Quality Matters Digital Learning Now
NCAA
Last modified Tuesday, February 04, 2014

APPENDIX D:

Kentucky Intervention Mathematics Materials Codes

3301	Accelerated Math	Math
3302	ALEKS	Math
3303	Cognitive Tutor	Math
3304	Education City	Math
3305	Everyday Mathematics	Math
3306	I Can Learn Pre-Algebra and Algebra	Math
3307	Math 180	Math
3308	Math Buddies	Math
3309	Math Pathways & Pitfalls	Math
3310	Math Recovery	Math
3311	Math Score	Math
3312	Math Triumphs	Math
3313	Mathematics Navigator	Math
3314	Number Worlds	Math
3315	PALS (Peer Assisted Learning Strategies) Math	Math
3316	Method Test Prep Math	Math
3317	PLATO Math	Math
3318	Saxon Mathematics	Math
3319	Scott Foresman Mathematics	Math
3320	SRA Connecting Math Concepts	Math
3321	Success Maker Math	Math
3322	Study Island Math	Math
3323	Voyager Math (V-Math)	Math
3324	Xtra Math	Math
3325	FASTT Math	Math
3326	Compass Learning Math	Math
3327	Triumph College Access Math	Math
3328	Edgenuity Math	Math
3329	Edmentum Math	Math
3330	Go Math intervention material	Math
3331	Cams and Stams	Math
3332	JCPS Math (e-School)	Math
3333	Other Math Intervention Resource	Math
3334	IXL Math	Math
3335	Front Row Math	Math
3336	Ready Common Core (Curriculum Associates) Math	Math
3337	Moby Max Math	Math
3338	Cambridge Educational Learning Math	Math
3339	WIN Learning Math	Math
3340	Odyssey Ware Math	Math
3341	Catch Up Math	Math

3342	Dreambox	Math
3343	Hawkes (developmental program)	Math
3344	Apex Learning Math	Math
3345	Starfall Math	Math
3346	My Foundations Lab	Math
3347	KHAN Academy	Math
3348	I Ready	Math
3349	Math Whizz	Math
3350	Cool Math	Math
3351	Star Math	Math
3352	Do Math Now	Math
3353	TenMarks	Math
3354	Matheletics	Math
3355	Fuel Education (Aventa) Math	Math
3356	Hands on Equations	Math
3357	Scootpad Math	Math
3358	Math in Focus	Math
3359	SRA Corrective Math	Math
3360	Do the Math (Marilyn Burns)	Math
3361	Ready Common Core Math	Math
3362	Pearson Cengage Learning Math	Math
3363	Coach Books Math	Math
3364	KY Center for Mathematics materials	Math
3365	Great Leaps Math	Math
3366	Everyday Counts Calendar Math	Math
3367	Pearson DIGITS	Math
3368	Triumph Learning Common Core Clinic Math	Math
3369	Reflex Math	Math
3370	CERTS Math	Math
3371	College Center Math	Math
3372	Common Core Progress Math	Math
3373	Education Galaxy Math	Math
3374	My Skills Tutor Math	Math
3375	NWEA Skills Pointer Math	Math
3376	edReady Math	Math
3377	Ladders to Success Math	Math
3378	Renaissance Place (Math in a Flash)	Math
3379	AVMR (Add+ Advantage Math Recovery)	Math
3380	Assessing Math Concepts by Kathie Richardson	Math
3381	Engage New York Math	Math
3382	KY Center for Mathematics (KCM) materials	Math

VITA

EDUCATIONAL EXPERIENCE

2015 – Present Eastern Kentucky University Ed Leadership & Policy Studies
2014-2015 Strategic Data Project Fellowship – Harvard Graduate School (CEPR)
2012-2013 (MA Ed.) University of the Cumberlands Master of Arts in Education (K-12)
2007-2008 (Rank 1) University of the Cumberlands Ed Leadership (K-12)
2002-2003 Cisco Networking Academy for Instructors (I.T. Grades 5-12)
1988-1990 (MA Ed.) Eastern Kentucky University General Elementary Education (Gr. 1-8)
1982-1985 (B.S.) Eastern Kentucky University General Elementary Education (Gr. 1-8)
Fall 1985 Student Teaching at Model Laboratory School (EKU)

CERTIFICATIONS

Professional Certificate for Instructional Leadership Supervisor of Instruction (K-12)
Professional Certificate for Instructional Leadership Principal All Grades (K-12)
Information Technology Grades 5-12 (LIFETIME)
Standard Elementary Certificate Grades 1-8
Educational Program Consultant
World of Webmasters Certified Web Developer Associate

RECENT PRESENTATIONS & PUBLICATIONS

Kentucky Department of Ed - *Novice Reduction Using Data Diagnostics Series* (2015)
Review Data Diagnostic Analyze Data Diagnostic Apply Data Diagnostic
Kentucky Department of Education – *Kentucky Digital Learning Guidelines* (2014)
Kentucky Digital Learning Guidelines Communication Document
Kentucky Department of Education – *Using Data for College/Career Readiness* (2013)
Data Analysis Protocol Video Data Analysis Protocol Presentation
Kentucky Department of Education – *Co-Teaching for Gap Closure* (2013)
High Yield Mathematics Strategies Presentation

EXPERIENCE

2015-Present Eastern Kentucky University
Fall 2016 - Graduate Assistant – Ed Leadership & Policy Studies Department
Spring 2016 - Adjunct Professor – Emerging Instructional Technologies Course
Fall 2015 - Adjunct Professor - Assessment in Education Course

2014-2015 **Kentucky Department of Education**
Research Analyst (Quantitative Student Outcomes)
State Education Strategic Plan Manager
Commissioner's Delivery Unit – Office of the Commissioner
Baldrige Performance Excellence & Continuous Improvement Team

2013-2014 **Kentucky Department of Education**
State Digital/Blended Learning Consultant
Digital Learning Strategy Lead
Kentucky Digital Learning Guidelines Lead Author

2011-2013 **Kentucky Department of Education**
Educational Recovery Specialist for Mathematics Gr. 9 – 12
Priority School Turnaround Team for
East Carter High School & Pulaski County High School

2011-2015 **Next Generation Appalachian STEM**
STEM Curriculum Director Grades 6-12

2009-2011 **Clark County Schools**
Elementary School Principal
SBDM Chairman

2006 – 2009 **Fayette County Schools**
2007-2009 Edythe J. Hayes Middle School Grades 6-8
Curriculum & Instruction Specialist
E.S.S. Coordinator
2006-2007 Crawford Middle School Grades 6-8
Academic Dean
Building Assessment Coordinator
C.S.I.P. Internal Building Facilitator

2005-2006 **Berea Middle/High - Berea Independent Schools**
6th & 8th Grade Math, Science, Technology Teacher

1997-2004 **Lincoln County Board of Education**
Academic Performance Specialist (2002-2004)
District Secondary Curriculum/Technology Integration Specialist (2000-2
7th-8th Grade Science Teacher (1997-2000)

1995-1997 **Summers - Kentucky Science and Technology Council**
Science Program Consultant & Presenter Statewide

1988 – 1997 **Clay County Board of Education**
Science Teacher Grades 5-8

1986–1987 **Perry County Board of Education**
Language Arts and Art Teacher Grade 8

ORGANIZATION MEMBERSHIPS (Past & Present)

Kappa Delta Pi Honor Society for Education
International Society for Technology in Education
Kentucky Society for Technology in Education
National Council for Teachers of Math
Leadership Winchester Graduate
Kentucky Association of School Administrators
Kentucky Association of School Councils
Association for Supervision and Curriculum Development
National Middle School Association
Toastmasters

CONFERENCE PRESENTATION & TRAINING EXPERIENCE

National Dropout Conference - *Increasing Student Engagement* (2015)
Strategic Data Project (Harvard) *College Going Diagnostic Statewide* (2014)
Midwest Education Research Association - *Kentucky Digital Learning Guidelines* (2014)
KY Society of Technology in Ed Conference - *Kentucky Digital Learning Guidelines* (2014)
Kentucky Department of Ed - *Algebra I Blended Learning Initiative* (2013)
Co-Teaching for Gap Closure – *Mathematics Co-Teaching Strategies* (2013)
Next Generation Math & Science Institute Curriculum Director (2012- Present)
Transformational Mathematics Framework (2011-Present)
MAP, ACT, Compass, and KYOTE Assessment Tools (2011-Present)
High Yield Instructional Strategies (2013)
Student Engagement Strategies (2013)
Creating Standards-based Assessments (Winter 2012)
POWER Strategies & Best Practices for Common Core Standard Instruction (Fall 2011 - Present)
Formative Assessment (Fall 2010 - Present)
Earth Science Lesson Modeling Grade 4 (Winter 2010)
Strategic Questioning Strategies for Cultural Equity (Fall 2010)
Kentucky American Water Science Fair Judge Fayette County (2009)
Descriptive Feedback on Science Open Response Items (Winter 2009)
Feeding Forward Video Modeling Descriptive Feedback in a Science Classroom (Winter 2009)
Science Standards Based Units of Study Project Leader (Fall 2008)
Open Response Assessment for Fayette County Public Schools Student Achievement Office (Winter 2008)
Varying Teacher Professional Developments (1993-2006)

RECOGNITIONS & HONORS

Strategic Data Project Fellowship Harvard Graduate School (CEPR) 1 Year
Baldrige Performance Excellence Team Award Levels I & 2
Kentucky Digital Learning Guidelines for Kentucky Department of Education
Data Analysis Protocol for School Improvement Video for Kentucky Department of Education

2010 Your Excellence Shows Award for Outstanding School Website (Clark County Schools)
2010-2011 Leadership Winchester Graduate
Toastmaster's International Communication & Success Leadership Speechcraft Graduate
Twice Featured in Kentucky Teacher Magazine for Middle School Curriculum & Instruction Coaching Strategies (March 2004 & January 2007)
Successful Grant Writing $216,700.00 total between 1999 and 2008
EdVentures Grant – EntreSchools Initiative Kentucky Science and Tech Council 2000-2002
Kentucky Land & Water Grant for Garrard Youth Sports Complex
Kentucky Science Teacher of the Year Nominee
Cumberland College Regional Science Fair Overall Winning School 4 years in a row
Short term missionary to Guatemala Summer 2005 & Pascagoula, MS Summer 2009