


Fall 2017

Co-Enrolling Students in Math Remediation and College-Level Math in a Community College System

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Anderson, Peter T. "Co-Enrolling Students in Math Remediation and College-Level Math in a Community College System" (2017). Doctor of Philosophy (PhD), dissertation, Educ Foundations & Leadership, Old Dominion University, DOI: 10.25777/1ysj-xx74 https://digitalcommons.odu.edu/efl_etds/61

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CO-ENROLLING STUDENTS IN MATH REMEDIATION AND COLLEGE-LEVEL MATH
IN A COMMUNITY COLLEGE SYSTEM

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirement for the Degree of

DOCTOR OF PHILOSOPHY

COMMUNITY COLLEGE LEADERSHIP

OLD DOMINION UNIVERSITY
December 2017

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ABSTRACT

CO-ENROLLING STUDENTS IN MATH REMEDIATION AND COLLEGE-LEVEL MATH
IN A COMMUNITY COLLEGE SYSTEM

Peter Thomas Anderson
Old Dominion University, 2017
Director: Dr. Mitchell R. Williams

The purpose of this study was to conduct a rigorous examination of co-enrollment of students in math remediation and college-level math. A quasi-experimental, posthoc design examined the outcomes and the relationships of two groups of students who participated in a pilot project the goal of which was to assess the co-enrolled model that is designed to provide students with mathematics support. One group of students enrolled in a traditional model of developmental mathematics. The second group of students co-enrolled in developmental and college-level math.

The sample for this study was students ($N = 7616$) from nine community colleges in a U. S. Southeastern state. Students were selected for this study who enrolled in co-enrolled in developmental math and college-level math simultaneously ($n = 208$) and a control group who enrolled in developmental and college-level math separately ($n = 7408$). All enrollments occurred during the fall 2016 and spring 2017 semesters. Co-enrolled students completed developmental and college-level math at higher rates than their developmental only peers. The co-enrolled students accumulated fewer credits and attained higher grades in college-level math than the developmental only students.

This dissertation is dedicated to my lovely wife, Julie,
who stood beside me in this chapter of our walk through life together.

To my son Ryan, and my daughters Brooke and Grace for understanding
the time's dad could not be there.

Without my wife and kids' love, support, and understanding,
this dissertation would not have been possible.

I love each of you so much!

We did it!

ACKNOWLEDGMENTS

Embarking down the road of a doctorate, at times, seemed like a road I may never take. The coursework at ODU and this dissertation have been a long road, but a road I do not regret traveling. I first and foremost thank God for opening this door of opportunity for me to step through. I can do all things through Christ who strengthens me! As stated in my dedication, I cannot thank my family enough for all the love, support, and sacrifices they made along this journey.

I have been lucky enough to be surrounded by fabulous people all of my life! I would not have finished my dissertation without the wisdom, guidance, and support of Dr. Dana Burnett. Dr. Burnett, your keen sense of guidance and words of wisdom at opportune times, were priceless! Dr. Shana Pribesh you are the method and program evaluation queen. Your experience and intelligence in how to get things done are amazing. You rock! Dr. Mitch Williams, you taught me so much over the past several years, but the most important thing you taught me was how to be a scholar and a leader. Drs. Burnett, Pribesh, and Williams, you are the best!

I am so blessed to work with the best colleagues anyone could ask for. The faculty, staff, and administrators at New River Community College are a joy and pleasure to work with. We work hard, but we have fun working hard! I thank each of you for your support and understanding the past few years I have spent at ODU. This dissertation would not be possible without the support of one of the finest people I have ever met and now work for, Dr. Patricia Huber, President of New River Community College. Pat, you are beyond a mentor. Your kindness, encouragement, and support were instrumental in my success in completing this dissertation. I thank you so much! Thank you, Dr. Fritz Streff! You are a true scholar and

wonderful researcher. I consider myself so lucky that our paths have crossed and I thank you for all your help with providing the data for this study.

To the wonderful Cohort 13 at Old Dominion University! Each of you has a special place in my heart. We endured our first Summer Institute where the fire alarm went off the first night at 4:00 a.m. The next morning, we all wandered to the far side of the campus where our first class happened. The rest is history! It has been an honor and a privilege to work with such wonderful people in Cohort 13. Dr. Chris Glass you are the man! You ensured and kept my colleagues and me in Cohort 13 on our toes at all times. Your combination of high expectations with high support is a recipe for success. I thank you so much for all you have done for my colleagues and me.

To my colleagues at the Virginia Community College System, I thank you! Dr. Catherine Finnegan and Aris Bearse, you both were instrumental in my data request process and offering your guidance along the way.

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CHAPTER 1

Introduction

In the United States, almost two-thirds of community college students are not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015; Jaggars & Hodara, 2013). Colleges have addressed this lack of college readiness with math and writing developmental education programs. (The terms developmental and remedial are used interchangeably in this study.) The purpose of math developmental education programs is to provide students that have weak academic skills the opportunity to strengthen those skills in preparation for college-level math coursework (Bailey, Jeong, & Cho, 2010; Bettinger & Long, 2005). Less than half of the students that begin developmental math complete it, and even fewer graduate (Bahr, 2010, 2012; Bailey et al., 2015).

Background

Developmental education is one of the greatest challenges confronting community colleges. Students enter community colleges with under-prepared academic skills, planning to earn a degree, a certificate, or to transfer to a four-year institution. Students are often assessed in math and English skills with the use of a one-shot placement exam (Scott-Clayton, Crosta, & Belfield, 2014; Scott-Clayton & Rodriguez, 2012). Once students enter developmental education, completing it can be difficult. Colleges often have not coordinated their developmental curriculum with their college-level curriculum, leaving students confused, due to the lack of seamless transition from developmental courses to college-level courses. The lack of curriculum alignment creates an unintended barrier for students (Bailey, 2009). Budget reductions have magnified problems for colleges attempting to properly implement developmental education due

to the high cost to colleges for these developmental programs (Fong, Melguizo, & Prather, 2015). Policy makers and college leaders face the difficult task of guiding colleges' efforts to support students with skill deficits with the historical tools available in developmental programs (Bailey et al., 2015; Cohen, Brawer, & Kisker, 2013). Students lacking appropriate academic skills struggle to navigate the complexity of the developmental education system. Unfortunately, some students do not experience success in developmental education and drop out of college (Bailey & Jaggars, 2016; Jaggars & Hodara, 2013). Some colleges have initiated new models of support that provide intense academic support with college-level math courses to circumvent developmental math (Bailey & Jaggars, 2016).

Leadership and public policy. Developmental education decisions made by community college leaders are rooted in public policy (Fong et al., 2015). Public policy is defined as structuring government and society actions, based on knowledge, around solved collective problems (Klimeczuk, 2015). In a U.S. Southeastern state, the developmental education solutions to the developmental education problems are managed by a community college system serving (System Office) a U.S. Southeastern state. The System Office Developmental Education Policy is outlined in the System Office Policy Manual. Community college leaders in a U.S. Southeastern state have implemented developmental education programs, in part, by following the System Office Developmental Education Policy.

Developmental education's success or failure is dependent, in part, on policy and leadership (Bailey, 2009). Reforms such as multiple measure assessment, and intense academic support during college-level coursework, have challenged leaders to change policy (Bailey, 2009; Bailey & Jaggars, 2016). Leadership is a highly valued and a highly sought-after commodity (Northouse, 2016). Leadership is defined as "...a process whereby individual

influences a group of individuals to achieve a common goal” (Northouse, 2016, p. 6).

Developmental education reform may have happened as a result of reaching common goals, rooted in research-based policy. Underprepared students grew in numbers over the past decade, and policymakers and leaders examined this change to reform developmental education (Bailey & Jaggars, 2016; Bailey et al., 2015).

Underprepared students. Many underprepared students do not recognize that they are underprepared (Bol, Campbell, Perez, & Yen, 2016). There are three types of underprepared students: culturally underprepared, emotionally underprepared, and academically underprepared (Bettinger & Long, 2009). This study will focus on the academically underprepared student. The most academically underprepared students are often referred to a sequence of three or more developmental courses designed to prepare them for college-level work (Bailey & Jaggars, 2016; Bailey et al., 2010). However, only 11% of students enrolled in three or more developmental math courses typically complete a college-level math course (Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015). Often underprepared students’ placement exam did a poor job of predicting success in college-level coursework (Bailey & Jaggars, 2016). Bailey et al. (2015) suggested that a multiple measures approach would do a better job of assessing and placing students.

Utilizing multiple measures when assessing and placing students. Properly assessing and placing community college students in appropriate courses is an important factor for increasing student completion rates (Bailey & Jaggars, 2016; Collins, 2008). Completion rates include course completions and program completions. Placement tests alone do not yield the best predictions of how students will perform in college (Armstrong, 2000; Bailey & Jaggars, 2016; Bailey et al., 2015; Belfield & Crosta, 2012; Collins, 2008). However, high school grade point

average (GPA) has proven effective in predicting college GPA and college credit accumulation (Bailey & Jaggars, 2016; Belfield & Crosta, 2012). Students are more likely to be under-placed in remedial coursework than over-placed in remedial coursework (Bailey & Jaggars, 2016; Scott-Clayton & Rodriguez, 2012). The under-placement of students suggests that placement exam cut-off scores are too high therefore placing students unnecessarily in developmental education (Bailey & Jaggars, 2016). Student high school metrics such as the number of math and English courses taken, honors courses, the number of F grades, and the number of credits, have proven more beneficial when assessing and placing students (Bailey & Jaggars, 2016; Belfield & Crosta, 2012).

Good placement and assessment policies have included, students' assessed skill levels and placement using multiple measures, consistent standards across colleges, and using comparable data related to students' high school outcomes (Collins, 2008). Clear placement and assessment policies have improved students' college readiness through clearer communicated policies, and communicated expectations that students must achieve (Collins, 2008; Scott-Clayton & Rodriguez, 2012). Good placement and assessment policy is not simply about a cut-off score but contains a developed, common understanding of what college readiness means (Collins, 2008; Scott-Clayton & Rodriguez, 2012). However, experts disagree on the definition of college readiness (Bailey & Jaggars, 2016; Bailey et al., 2015; Belfield & Crosta, 2012).

Accelerated curriculum structures. The majority of developmental students drop out of college before completing their developmental course sequence due to a failed course, or because they cannot enroll in the next course in the sequence due to lack of course offerings (Bailey & Jaggars, 2016; Bailey et al., 2015; Scott-Clayton & Rodriguez, 2012). Due to high attrition rates, colleges have experimented with accelerated curriculum structures wherein students complete

remedial courses sooner (Bailey et al., 2015). Acceleration of remedial coursework reduces exit points and matches learning outcomes with college-level courses (Bailey & Jaggars, 2016; Bailey et al., 2015). Colleges have also adapted curriculum and programs to the co-enrolled model wherein academically underprepared students bypass traditional developmental coursework and enroll in college-level courses with intense academic support (Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars, Hodara, Cho, & Xu, 2015). Colleges have attributed student success to the co-enrolled model by creating an assigned accelerated case manager, assigning students to success courses, and membership in learning communities (Bailey et al., 2015; Jaggars et al., 2015). These aforementioned student success strategies have helped to increase overall fall to fall retention rates of students (Bailey et al., 2015; Jaggars et al., 2015). Even students with the lowest test scores on placement tests have been successful in the co-enrolled model, but these lower performing students are reported to have had strong academic support while they took college-level coursework (Jaggars et al., 2015).

Challenges of developmental education. The developmental education process seems straightforward enough. Underprepared students are assessed and placed into remedial coursework designed to prepare students for college-level coursework (Bailey et al., 2015; Cohen et al., 2013; Jaggars et al., 2015). Students complete the remedial coursework and move on to success in college. However, this presumed straightforward process is filled with complexity and confusion (Scott-Clayton & Rodriguez, 2012). Students achieve poor outcomes in the model that assigns them remedial coursework as a detour before they are eligible to take a credit course. (Jaggars & Hodara, 2013). Inadequate test preparation, insufficient placement exams, poorly aligned curriculum, ineffective skill-and-drill instruction, insufficient time, and financial resources needed to complete a remedial course sequence, are all explanations that have

been correlated with developmental students' lack of progression (Jaggars & Hodara, 2013). Students who tested barely below the level of college readiness, and who took one remedial course, did not increase their likelihood of long-term progression to college-level coursework (Bailey & Jaggars, 2016). In their analysis of a recent study, Bailey and Jaggars (2016) commented that for, "students who are referred to three remedial math courses, only 11 percent completed college-level math within three years" (p. 1).

Summary. The traditional developmental education system has failed students (Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars & Hodara, 2013). Some students who were referred to remedial coursework did not need it (Bailey & Jaggars, 2016; Belfield & Crosta, 2012). For those students who needed remedial coursework, integrated intense academic support with college-level coursework has proven more successful (Bailey & Jaggars, 2016). According to Bailey and Jaggars (2016), "the spread of the co-enrolled model is perhaps the most significant development in the remediation reform movement in the past two years." (p. 8). New policy efforts, fueled by current research, have assisted the majority of students with academic support integrated with college-level coursework (Bailey & Jaggars, 2016; Bailey et al., 2015). Students who have scored the lowest on placement exams may have succeeded in co-enrolled programs, but they may be more successful in the more traditional model of developmental education (Bailey & Jaggars, 2016; Bailey et al., 2015). The better way to place the lowest skilled students is to use multiple measure assessments, combined with in-person advising; therefore, placing these students in a traditional model of developmental education (Bailey & Jaggars, 2016; Bailey et al., 2015).

Statement of the Problem

Across America, nearly two-thirds of community college students are not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars & Hodara, 2013). These underprepared students typically are placed into remedial coursework. Unfortunately, a majority of these students will not complete developmental education and will drop out of college (Bailey & Jaggars, 2016; Jaggars & Hodara, 2013). The lack of success students have experienced with developmental education in America's community colleges is widespread. There is scant research on the new model of co-enrollment of developmental math and college level math, and this study attempts to fill in the gap.

Purpose of the Study

The purpose of this study is a rigorous examination of co-enrollment of students in math remediation and college-level math. A quasi-experimental, posthoc design will be used for this study. This study will examine the outcomes and the relationships of two groups of students who participated in a pilot project the goal of which was to assess the co-enrolled model that is designed to provide students with mathematics support. One group of students enrolled in a traditional model of developmental mathematics only and served as a control group for this study. The second group of students co-enrolled in developmental and college-level math.

Research Questions

Therefore, the goals of this present study are to ascertain answers to the following research questions:

1. For students in the two groups of community college students in the sample under study, is there a difference in the completion of developmental math courses by the end of the spring 2017 semester?
2. Is there a difference in the completion of college-level math courses by students in the two groups by the end of the spring 2017 semester?
3. For the two groups in the study, is there a difference in the grades of students in their college-level math courses by the end of the spring 2017 semester?
4. For the students in the sample, is there a difference in the number of credits that students completed by the end of the spring 2017 semester?
5. Is there a difference in the completion by students in developmental math courses by college type, using the criteria of rural and urban?

Overview of Methodology

A quasi-experimental, posthoc design will be used for this study. The sample of this study will be students ($N = 7606$) from nine community colleges who participated in a pilot project the goal of which was to assess programs designed to provide students with mathematics support. Students who participated in the pilot project during the Fall 2016 and Spring 2017 semesters will comprise the sample for this study.

Significance of the Study

The results of this research study may fill a void found in the current research literature related to the relationships, if any, of student outcomes for who are co-enrolled in developmental math and college-level math. The two student groups are

- a. In a developmental only math course
- b. Co-enrolled in mathematics developmental education support and college-level math

The study's potential significance is that the current model of developmental math is very often not successful and this study will assess the efficacy of the co-enrolled model for supporting students in the math curriculum.

Definitions of Key Terms

Various terms were found during this scholarly literature review inquiry that has various meanings and in a variety of contexts. The following list of definitions is offered to specify the intent of this researcher in use of these terms:

Co-enrollment – An individual student that enrolls in remedial math and college-level math concurrently.

Co-requisite remediation – Remediation that occurs at the same time as college-level coursework.

College-level math course – Any math course that students' receive college credit upon completion.

Cumulative Grade Point Average (GPA) – The grade point average a student earns that encompasses their entire coursework at a given higher education institution.

Degree-seeking student – A student that has declared their intended major of study at an institute of higher learning.

Developmental math course – Any math course that is preparatory in nature that prepares students for college-level math coursework.

Developmental student – A student that is currently enrolled or has taken developmental coursework.

Enrollment status – A dichotomous variable indicating whether a student is full-time or part-time. For this study, part-time is a credit load up to 11 credits, and full-time is a credit load of 12 credits or more.

Financial aid status – A dichotomous variable whether a student is or is not eligible for a Pell grant.

First generation status – A dichotomous variable whether a student is the first person in their family to achieve a bachelor's degree.

Non-degree-seeking student – A student that has not declared a major study of interest that may be taking courses for personal benefit.

Placement test – A test given to students, before taking coursework, typically in math and English for appropriate placement.

Summary

A minority of students who are placed into developmental education progress to college-level math and ultimately to graduation (Scott-Clayton & Rodriguez, 2012). Leaders have examined current research to make the best policy decisions to positively affect developmental education (Bailey et al., 2015). Academically underprepared students are typically assessed and placed using an inaccurate one-shot exam (Scott-Clayton & Rodriguez, 2012). The lack of curriculum alignment between developmental and college-level coursework added to the confusion students' experience when attempting to navigate the developmental education system (Bailey & Jaggars, 2016; Bailey et al., 2015; Cohen et al., 2013). The low completion rates of students placed in developmental classes cost students and society billions of dollars each year (Martinez & Bain, 2014). Integrated intense academic support while students took college-level math may have been a better solution for students than the traditional model of remediation

where many students failed to complete (Bailey & Jaggars, 2016; Bailey et al., 2015). This study will examine the efficacy of co-enrolled math supports with college-level math courses.

CHAPTER 2

Review of the Literature

In the United States, almost two-thirds of community college students are not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars & Hodara, 2013). Colleges have addressed this population growth and the variations in college readiness with extensive developmental education programs. (The terms developmental and remedial are used interchangeably in this study.) The purpose of developmental education programs is to provide students that have weak academic skills the opportunity to strengthen those skills in preparation for college-level coursework (Bailey et al., 2010; Bettinger & Long, 2005). Less than half of the students that begin developmental education complete it, and even fewer graduate (Bahr, 2010, 2012; Bailey et al., 2015).

The following mind map analysis was formed from the researcher's scholarly review of the literature. Due to policymakers new thrust of performance-based funding, gateway math course acceleration has been a primary issue. Most majors require at least one math course; therefore students need to succeed in math to succeed in college. Supplemental Instruction (SI) has played an important role in students succeeding in some of the more difficult courses in college. Many of the successful SI strategies can be used in producing successful remedial education programs. However, community college students' needs for SI differ from four-year university students' SI needs. Most often, community college students need SI for remediation; whereas their four-year university counterparts need SI for the most difficult courses. The social and academic integration to college is a major barrier for many community college students. For

students to be successful in college, they must be properly assessed and placed in college-level and remedial coursework.

Financial Constraints Urge A Call To Action

To achieve the national goals of increasing college completion rates with scarce resources, broad access postsecondary institutions, such as community colleges, must have graduated a larger percentage of those who begin their studies. (Baum, Ma, & Payea, 2010; Jenkins & Rodriguez, 2013). Leaders across America believe that greater individual and organizational accountability has had a positive impact on outcomes and morale (Connors & Smith, 2011). Greater accountability leads to game-changing results in any organization (Connors & Smith, 2011). Undergraduate education has required improvements that are sparked by the commitment and action of students and faculty (Chickering & Gamson, 1987). Contemporary students are a diverse group. They vary in their approaches to college, in demographic characteristics, in family backgrounds, in their pathways through college, and in their readiness for college (Goldrick-Rab & Cook, 2011). Students in the twenty-first century seem much less interested in academics than ever before (Goldrick-Rab & Cook, 2011).

The common practices of using more part-time instructors and increasing student-faculty ratios to reduce expenditures may have simultaneously reduced productivity and efficiency (Jenkins & Rodriguez, 2013). Jenkins and Rodriguez (2013) argue “that as policymakers push colleges to lower the cost per graduate, they must avoid providing incentives to lower academic standards” (p. 187). As a broader socioeconomic group of high school students have entered college, policymakers and practitioners must also consider how to educate all students utilizing the most efficient and effective means (Goldrick-Rab & Cook, 2011). American higher education

must find ways to accommodate a very diverse cultural, economic, and social student body (Goldrick-Rab & Cook, 2011).

Accounting for all types of institutions in higher education, community colleges were the only sector that spent less per degree completed in 2009 than they did in 1999 (Jenkins & Rodriguez, 2013). Accountability that happens when you have done something wrong was not effective; accountability that focuses on how institutions conduct their business, that led to individual and organizational success, was most effective (Connors & Smith, 2011). Connors and Smith (2011) added that “creating an organizational culture where people embrace their accountability toward one another, and the organization should occupy center stage in an effort to create successful organizational change” (p. 2). Proper accountability produces greater transparency and openness, enhanced teamwork and trust, effective communication and dialogue, and a tighter focus on results (Connors & Smith, 2011).

Broad access institutions have recently focused on reducing the cost of producing degrees. Course redesign has resulted in positive results for reducing costs and improving outcomes (Jenkins & Rodriguez, 2013). Revamping online courses have proven to be problematic because most underprepared students perform worse in online courses than in face to face courses (Jenkins & Rodriguez, 2013). By creating more clearly defined pathways of study and aligning them with requirements for further education and employment, community colleges have improved productivity (Jenkins & Rodriguez, 2013).

Numerous reports detail the primary issues in higher education, but not much effort in research has been expended in the arena of solutions to the issues (Chickering & Gamson, 1987). Chickering and Gamson (1987) outline seven principles of good practice in undergraduate education:

1. “Encourages contacts between students and faculty.
2. Develops reciprocity and cooperation among students.
3. Uses active learning techniques.
4. Gives prompt feedback.
5. Emphasizes time on task.
6. Communicates high expectations.
7. Respects diverse talents and ways of learning” (p.2).

These guidelines, when adopted, have improved teaching and learning (Chickering & Gamson, 1987).

Gateway Math Course Acceleration

Success rates for students earning a postsecondary college credential are lower when they begin their studies in developmental math courses. Concerned policymakers and college leaders who reviewed completion rate data have focused efforts on transforming remedial education in many states (Bailey et al., 2015; Cohen et al., 2013; Jaggars & Hodara, 2013; Scott-Clayton, Crosta, & Belfield, 2014; Vandal & Complete College, 2014). Placing students into multi-semester, non-credit remedial course sequences as a pre-requisite to enrollment in college-level math, resulted in most students leaving the system and never making it to a college gateway course (Bailey et al., 2015; Vandal & Complete College, 2014). “The research is clear; long remedial education course sequences are a barrier, not a bridge, to college” (Vandall & Complete College, 2014, p. 1). However, placing students directly into college-level math that provided them with additional academic support as a co-requisite saw greater college-level math success for students (Vandal & Complete College, 2014). “With co-requisite models showing success rates in college-level gateway courses that are two to three times better than the traditional

model,” college leaders and policymakers across the states moved to implement co-requisite remediation (Vandall & Complete College, 2014, p. 1). Co-requisite remediation is the delivery of academic support to students while simultaneously being enrolled in college gateway courses (Bailey & Jaggars, 2016; Vandal & Complete College, 2014).

Community college best practices. In California, where community colleges were required to use multiple measures to place students, students’ access and success were found to increase in college-level courses (Ngo & Kwon, 2015). “Although developmental courses can serve as necessary and helpful stepping-stones to college success, they also delayed access to critical gateway courses necessary for degree attainment or transfer to 4-year colleges” (Ngo & Kwon, 2015, p. 443). Students placed in lower levels of remedial math have low success rates in college-level math, and these students incur substantial costs in the form of time and money; therefore, the need for accurately accessing and placing students was critical (Ngo & Kwon, 2015). The results of Ngo and Kwon’s (2015) study showed that “students who were placed into higher-level courses using information from multiple measures, in this case, high school GPA and prior math courses, performed no differently from their peers who earned higher test scores” (p. 464). Community colleges using student background information in addition to assessment data improve placement accuracy and student success (Ngo & Kwon, 2015).

Edgecombe stated that “mounting evidence suggests that the traditional sequence of developmental education courses hindered community college students from entering college-level coursework and ultimately earning a credential” (p. 1). This study, which used 2010 data from participants in Achieving the Dream, found that only 33% of students referred to any level of developmental math completed their course sequence within three years (Edgecombe, 2011). Only 17% of students who placed in the lowest levels of developmental math completed their

course sequence in three years (Edgecombe & Columbia University, 2011). “The traditional sequence of developmental courses undermined academic achievement in part because it has a multitude of exit points (Edgecombe & Columbia University, 2011, p. 1). Students chose never to enroll or dropped out between courses in the sequence (Bailey & Jaggars, 2016; Bailey et al., 2015; Edgecombe & Columbia University, 2011). Consequently, the lack of sequence success led many practitioners to experiment with restructuring the developmental math sequence of courses (Bailey et al., 2015; Bailey, Jeong, & Cho, 2010; Edgecombe & Columbia University, 2011). Acceleration of developmental math courses involved reorganizing the curricula in ways that expedited the completion of coursework (Edgecombe & Columbia University, 2011). Examples of acceleration were course restructuring and mainstreaming (Edgecombe & Columbia University, 2011). Course restructuring involved course-taking strategies such as compressed courses and paired courses (Edgecombe & Columbia University, 2011). Compressed courses allowed students to complete multiple levels of courses in one semester and paired developmental courses with college-level courses concurrent in the same semester (Bailey & Jaggars, 2016; Edgecombe & Columbia University, 2011). Mainstreaming strategies accelerated student progress by placing them directly in college-level math courses; sometimes they needed a little supplemental support or supplemental instruction (Edgecombe & Columbia University, 2011).

Only 6% of California’s community college students who placed into at least three levels of remedial math completed a college-level math course in three years (Hern & Snell, 2014). According to Hern and Snell (2014), California’s community colleges were, therefore, rethinking remedial course sequences and the student placement process. First, accelerated models such as single semester remedial courses were opened to students with any placement score. Second,

courses were provided that enable students to enroll in college-level math with additional concurrent academic support (Hern & Snell, 2014). Third, accompanying changes occurred in the classroom that included instructional design techniques that assisted faculty in offering high-challenged, high-supported accelerated courses (Hern & Snell, 2013). Students saw beneficial outcomes in college-level math by faculty that focused on the problem of attrition in long remedial sequences and created shortened, redesigned math curricula (Hern & Snell, 2010).

Curriculum reform and non-cognitive factors. A primary challenge to course redesign was program review practices that rarely looked at what happened to students semester to semester. Across programs of study, students showed a lack of progress (Jaggars & Hodura, 2013). Prior quantitative research focused on pass rates of individual courses, rather than longitudinal cohort studies that spanned the range of college programs (Bailey, Jenkins & Jaggars, 2015). Central to the curricular math reform was the formation of accelerated math pathways that aligned remediation with the specific college-level math requirements taken by students (Bailey & Jaggars, 2016).

Researchers have shown that college students who placed three levels below their first credit-bearing mathematics course have an unacceptably low pass rate in their developmental math courses (Bailey et al., 2010). Myra Snell's research found that only 18% of the students at Los Medanos Community College in California who started two levels below college level mathematics passed their developmental courses (Hern & Snell, 2014). These figures seem alarmingly low, and much work needs to be done to increase gateway math course completion. A new conceptual model aimed at increasing gateway math course completion is best represented as a three-legged stool, as a way to visualize the relationship of the components (Mireles, Acee, & Gerber, 2014). The seat was the gateway or college level math course, and the legs of the stool

that support the seat were developmental mathematics, learning support, and academic support services (Mireles et al., 2014). A novel aspect of the new model was the inclusion of learning support, real-world problems, hot topics, and question and answer sessions (Mireles et al., 2014). The learning supports helped to better contextualize college-level mathematics (Mireles et al., 2014). Students who placed into developmental mathematics and concurrently enrolled in college-level algebra made statistically significant improvements in their mathematics proficiency (Mireles et al., 2014).

Expanding instructional time in high school has been a popular strategy for improving the academic outcomes of low-skilled high school students (Nomi & Allensworth, 2009). There have been many strategies for improving the rigor of high school coursework so that all graduates are college ready. There has been increasing criticism that high schools are not sufficiently preparing students for college or the workforce (Nomi & Allensworth, 2009). “Furthermore, there was growing consensus that success in the workforce requires the same skills that students need for college” (Nomi & Allensworth, 2009, p. 112). There was also a concern for the high number of students failing ninth grade high school courses such as algebra (Nomi & Allensworth, 2009). “It was widely recognized that many students entered high school with weak math skills” (Nomi & Allensworth, 2009, p. 112). The situation of educating students entering high school with academic abilities well below grade level was a real challenge (Nomi & Allensworth, 2009). By introducing a second course, concurrent with ninth grade algebra, test scores have improved substantially (Nomi & Allensworth, 2009). To be successful, a double dose of ninth grade algebra must also have included strategies to improve students’ behaviors and attendance which seem to be the two most significant barriers to succeeding (Nomi & Allensworth, 2009).

Researchers have identified non-cognitive factors that relate to achievement in mathematics. “Among the affective variables identified in the literature were students' academic self-concepts, attitudes toward success in mathematics, confidence in their ability to learn mathematics, mathematics anxiety, test anxiety, perceptions of the usefulness of mathematics, motivation, self-esteem, and locus of control” (Thomas & Higbee, 1999, p. 1). Thomas and Higbee (1999) added that the relationships between cognitive factors such as learning styles, visual and spatial ability, critical thinking skills, and overall performance in mathematics affected the students’ success in mathematics. Collaborative learning has produced better attitudes for overcoming negative behaviors towards learning mathematics for students where they worked in small groups making predictions through the use of probability theory (Thomas & Higbee, 1999). “The primary implication of this research was that developmental educators could not ignore affective barriers to mathematics achievement” (Thomas & Higbee, 1999, p. 4). Student mastery of math concepts may not be enough for students to be successful in developmental mathematics (Thomas & Higbee, 1999). “Student attitudes toward mathematics and themselves as learners were related to achievement” (Thomas & Higbee, 1999, p.4).

Supplemental Instruction

Supplemental Instruction (SI), also known as peer-assisted learning and peer-assisted study sessions, is a popular type of academic support initiative where senior students facilitate peer learning between undergraduates studying high-risk courses (Arendale, 1994; Blanc, DeBuhr, & Martin, 1983; Congos, 2002; Dawson, van der Meer, Skalicky, & Cowley, 2014). The SI Program integrated “academic skills with course content in a series of peer-facilitated sessions that were voluntarily attended by students enrolled in these courses” (Dawson et al., 2014, p. 610). Each SI session was led by a senior student who was previously successful in the course

and had good interpersonal skills (Dawson et al., 2014). The leader was not a tutor or teaching assistant; the leader was “responsible for facilitating discussion around course content and related study skills; the leader also was there for preparing learning activities such as worksheets, group work, problem-solving exercises, or mock exams for their students” (Dawson et al., 2014, p. 610). The students who attend the SI sessions worked collaboratively teaching each other the course content and solving problems (Dawson et al., 2014). Leaders also participated in the process by taking notes, reading course content, attending lectures, and demonstrating effective study skills (Dawson et al., 2014).

Academic supports. Many community colleges have been increasing academic support services to reduce student attrition (Bailey et al., 2015; Blanc et al., 1983; Cohen et al., 2013). Many factors seem to affect retention rates. Among these are “student perception of progress toward an academic career goal, a high level of faculty-student interaction, and personal counseling and academic advising programs” (Blanc et al., 1983, p. 80). Blanc et al. (1983) added that a general upgrading of educational services also increased retention. Allowing students to access SI early on in the semester and in their developmental course sequence gives students greater outcomes and completions in college-level math (Blanc et al., 1983). Students realize better outcomes in college-level math when SI is attached directly to the course, when students do not view SI as a remedial program, when SI sessions are designed to have high levels of student collaboration and support, and when SI sessions were led by qualified faculty (Arendale, 2002; Blanc et al., 1983).

The principal components of a successful SI program consist of faculty, SI leaders, and a diversified study body (Rabito, Hoffman, & Person, 2015). Much of the success of SI programs relies on the collaboration of these three groups (Rabito et al., 2015). Some studies of SI

program reported an impact on academic achievement based on ethnicity (Rath, Peterfreund, Xenos, Bayliss, & Carnal, 2007; Shaya, Petty, & Petty, 1993). However, few published studies evaluated the relationships between demographic and academic preparation variables to academic achievement in community colleges (Rabito et al., 2015). Rabito et al. (2015) study aimed to fill in that gap in the research literature. It evaluated the relationships between “student demographics and academic preparation, faculty and SI member demographics, levels of participation in SI, and academic achievement” (Rabito et al., 2015, p. 243). The strongest correlate to the final course grade was prior grade point average (GPA) (Rabito et al., 2015). After controlling for the effects of input demographics, the strongest predictor of a higher final course grade was numbers of SI sessions attended (Rabito et al., 2015). The results of this study suggest that “the impact of both demographic and academic preparation variables should be considered when evaluating the effectiveness of SI programs on community college campuses” (Rabito et al., 2015, p. 249). SI participation was a positive predictor of the final course grade and final cumulative GPA (Rabito et al., 2015).

The academic performance and retention successes of students who have experienced SI have been well documented in various articles in numerous professional journals (Arendale, 1994; Blanc et al., 1983; Congos, 2002; Dale, 1969; Dawson et al., 2014; Weinstein & van Mater Stone, 1993). From the early theories of Edgar Dale’s Cone of Experience to Jean Piaget and Constructivism, to Vincent Tinto’s Model of Student Retention, to Claire Weinstein’s work in Metacognition, all contributed as underpinnings to the design of the SI model (Weinstein & van Mater Stone, 1993). There was great potential for the positive impact of SI on retention, retained revenue, final course grades, and graduation rates (Congos, 2002). SI programs satisfied all of Chickering and Gamson’s Seven Principles for Good Practice in Undergraduate Education

(Chickering & Gamson, 1987). Examples of Chickering and Gamson's Principles fostered by effective SI programs were encouraged student-faculty contact, cooperation among students, active learning, communicated high expectations, and respect for diverse talents and way of learning (Chickering & Gamson, 1987).

Supplemental instruction best practices. Supplemental Instruction (SI) utilizes group work facilitated by trained peer leaders (PLs) to promote participatory learning versus passive learning (Dias, Cunningham, & Porte, 2016). Ultimately, mastered independent learning, critical thinking, and time-management skills of students enable them to succeed in developmental math coursework (Hurley, Jacobs, & Gilbert, 2006; Karp & Bork, 2012). Academic success during a student's first year in college is critical to college completion (Grillo & Leist, 2013; Peterfreund, Rath, Xenos, & Bayliss, 2008). However, the SI strategy was formed for high-risk college courses, not for high-risk students (Drake, 2011; Hurley et al., 2006; Phelps & Evans, 2006; Wright, Wright, & Lamb, 2002). Some studies have shown better student performance in developmental mathematics as a result of SI programs (Phelps & Evans, 2006). Other studies have found favorable results not based on SI programs, but based on motivation either part of the student or faculty (Drake, 2011; Wang, Betne, Dedlovskaya, & Zaritsky, 2012; Wright et al., 2002). The data of this study showed an increase in academic performance for developmental math, as measured by course pass rate, for the SI over the non-SI cohorts from 52% to 59% (Dias et al., 2016). "Overall, notwithstanding earlier literature to the contrary, our results to date supported the success of the SI strategy, even for developmental mathematics students" (Dias et al., 2016, p. 8).

Supplemental Instruction (SI), the use of trained student peer tutors leading course sessions with collaborative learning to foster student learning, has been used by colleges since

1973 (Hurley et al., 2006; Phelps & Evans, 2006). Still, the use of SI to increase student outcomes in developmental math coursework has been inconclusive (Phelps & Evans, 2006; Wang et al., 2012). Flek's et al. study aimed to investigate the impact of SI strategies on retention and academic performance of developmental math students at Hostos Community College during the spring 2013 semester (Flek, Welt Cunningham, Porte, Dias, & Baker, 2015). Prior research on the effects of SI programs in non-developmental mathematics showed that student performance and retention improved while decreasing withdrawal and failure rates (Kenney & Kallison, 1994; Phelps & Evans, 2006). The study of Flek et al. showed improvement for the SI cohorts regarding course retention and absolute performance or retention multiplied times performance (Flek et al., 2015). "Given the importance of course retention to student persistence and graduation, the initial results of the research were promising" (Flek et al., 2006, p. 49).

Since its introduction in 1973, SI has rapidly gained attention for aiding student performance, retention, and academic success (Clark & May, 2015; Phelps & Evans, 2006). Most researchers have agreed that SI programs influence academic success in historically difficult academic courses. There was no stigma attached to SI assistance since courses slated for SI assistance were typically some of the most difficult courses on a college campus (Arendale, 1998). Some students were unable to meet minimum standards required in entry-level courses. When this happened, students had difficulty in academics and social relationships that created the inability to interact successfully both socially and intellectually in campus life (Phelps & Evans, 2006). Specific to this study at Valencia Community College in Florida, for four concurrent semesters, students who attended SI sessions had an overall course grade point average (GPA) of 2.8 compared to a 1.7 GPA for students who did not attend any SI sessions (Phelps & Evans, 2006). "Supplemental Instruction was one of many programs that have shown

tremendous promise as a mechanism for an established climate of achievement for at-risk learners” (Phelps & Evans, 2006, p. 34).

Even as Supplemental Instruction (SI) gained support, its effects have not been sufficiently explored to determine whether or not such academic support programs like SI were successful in supporting community college transfer students (Clark & May, 2015). Clark and May’s (2015) study explored prior academic preparation, results of placement exams, and interventions provided by an SI. A collaborative environment girded the SI Program success, workshops on accelerated learning techniques, and individual tutoring (Clark & May, 2015). The site for this study is a public university in the University System of Maryland, and the participants are a cohort of transfer students entering their junior year in a nursing program (Clark & May, 2015). Participation of students in the SI Program resulted in higher grade point averages at the end of the first semester, and a reduction in the failure and drop rates from 15% to 7% (Clark & May, 2015). SI has earned the reputation as a “highly successful program that combines peer facilitation as well as an equal emphasis on content and skills, and it has been documented via evidence-based results as a successful academic support model (Malm, Bryngfors, & Mörner, 2011). The SI Program, originally called supplemental course instruction, was originally developed at the University of Kansas City to address high attrition rates in dentistry, medicine, and pharmacy (Clark & May, 2015; Phelps & Evans, 2006). Since then, SI has been regarded as a successful academic support model to address high attrition rates among all college students, especially underrepresented minority groups (Meling, Mundy, Kupczynski, & Green, 2013; Rath et al., 2007). Clark and May’s (2015) study found that students who attended seven or more SI sessions in a semester earned one letter grade higher and a GPA higher than 3.0 than those who attended six or fewer sessions (Clark & May, 2015). “The academic

support program discussed in this study had a significant impact on transfer students' academic performance, partly because its structure is based on tested predictors" (Clark & May, 2015, p. 510).

Adjunct and coordinated models. For the current study, two models of supplemental instruction (SI) were reviewed, adjunct and coordinated. The SI adjunct model gives students options to choose from like note organization, self-testing, and reasoning (Congos, 2002; Congos & Schoeps, 1998). Models of thinking, problem-solving, and effective learning skills allowed students in the adjunct model to have a greater assimilation of information (Congos & Schoeps, 1998). Students are directed more to be collaborative learners working together to solve problems than the SI leaders just giving the students the answers. Students are invited to attend the adjunct model with no mandatory meetings (Snow & Brinton, 1988). David Arendale (1994) described the adjunct model where individuals are assisted on an "as needed" basis, and the students decide when assistance is needed.

The coordinated SI model involved more than just tutoring of a single subject like the adjunct model. The coordinated model included widespread, interdisciplinary faculty involvement (Arendale, 1994; Wild & Ebbers, 2002). Coordinated activities could have included, but are not limited to, a variety of participatory assignments such as discussions, guest speakers, lectures, and group activities (Wild & Ebbers, 2002).

The nine colleges of the Math Pathways Project are in the infancy stages of the coordinated model. The colleges have a robust past of the adjunct model. Students were placement tested and then given mandatory academic support. Of course, other academic supports such as optional tutoring were offered but not mandatory. The nine community colleges are beginning to group these students into cohorts to offer them increased levels of social,

emotional, and academic support from interdisciplinary faculty, support staff, and tutors. The coordinated effort focused on the success of these students in all subjects, not just developmental or college-level math.

Outcomes Education and Leadership

A community college president's success depends on the ability to engage the academic community in making choices among the many financial and physical resources (Dickeson, 2009). Performance-based funding (PBF) is utilized by policymakers to force colleges and universities to produce increased retention and graduation outcomes in higher education (Dougherty, Jones, Lahr, et al., 2014). The relationship between financial resources and academic quality had always been there, but now college leaders must do more with less and have become ultra-efficient in allocating resources (Dickeson, 2009). The leadership rhetoric must align with the mission of each community college, and each mission was different because community colleges serve their communities, and each community has its differences (Dickeson, 2009).

Institutions have made changes in developmental education, counseling and advising services, and course articulation and transfer between two and four-year colleges, to have raised outcomes and obtained funding via PBF policies and guidelines (Dougherty, Jones, Lahr, et al., 2014). There are numerous obstacles in responding to PBF policies such as inappropriate metrics, insufficient institutional capacity, and changing the academic and demographic composition of student bodies (Dougherty, Jones, Lahr, et al., 2014). Unfortunately, unintended metrics like restrictions on college admissions and the weakening of academic standards surfaced as a result of colleges implementing PBF policies (Dougherty, Jones, Lahr, et al., 2014). Retooling advising and counseling services and changing tutoring and SI were common campus-

level student services changes (Dougherty, Jones, Lahr, et al., 2014). Performance funding programs “largely fail to find evidence that performance funding improves graduation or retention, although there is evidence of some interesting localized impacts” (Dougherty, Jones, Lahr, et al., 2014, p . 40). If PBF was not increasing outcomes, the failure might be due in large part to obstacles institutions encountered trying to implement new PBF policies and procedures (Dougherty, Jones, Lahr, et al., 2014).

A new leadership era. While new funding demands are thrust upon institutes of higher learning, a new era emerged requiring college leaders to reallocate resources to accomplish increased student success Dickeson (2009), “offers a sounds conceptual framework and a set of processes for clarifying institutional purpose and setting academic priorities” (p. xiii). Community college leaders will have to increase the quality of academic programs while strengthening their college’s reputation, doing this with decreased resources (Dickeson, 2009).

College presidents are different than corporate CEOs; Corporate CEOs respond to the bottom line maximizing profits, while college presidents are resource maximizing (Dowd & Shieh, 2014). Dowd and Shieh (2014) defined resource maximizing as doing more with less than ever before. Dowd and Shieh (2014) added that from 2005 to 2010, community college associate’s degree-granting institutions experienced a 5.3% decrease in average state subsidy per full-time equivalent (FTE) student. Community colleges, unlike their university peers, were not well positioned to diversify their revenues (Dowd & Shieh, 2014). The weak relationship between tuition increases and changes in enrollment has produced a situation that was contrary to the principle of the direct relationship between supply and demand. As tuition costs have increased there has not been a corresponding drop in enrollment (Dowd & Shieh, 2014). Students cannot offset tuition increases in the present and therefore students loans and student debt

increased. What was not clear is whether tuition increases stop low-income students from attending community colleges (Dowd & Shieh, 2014). Community colleges were given the task to serve populations with higher needs but were given fewer resources per student to accomplish student success (Dowd & Shieh, 2014).

Barriers to successful college completion. The American community college has been faced with many financial and programmatic challenges that shaped the future decade of what community colleges in America will become (Cohen et al., 2013). During the 1990s, a new movement persisted where local funding and control gave way to state-level management (Cohen et al., 2013). Student demographics were changing, and faculty perceptions of wanting high-quality students may not be the students that occupied the classrooms (Cohen et al., 2013). Reductions in available funds, performance-based funding, ever-changing technology, and evolving student personnel functions were major challenges facing American community colleges (Cohen et al., 2013). Student literacy, the stabilization of the liberal arts, redefining the principles of general education, the rise of occupational education, and adult and continuing education were important aspects of the American education system and to student success (Cohen et al., 2013). The role community colleges played in leveling class structure, and enhancing student progress toward higher degrees were important questions raised about community colleges.

For students to succeed in college and developmental math education, community colleges implemented better admissions practices. Heil et al. (2014) added that “college selectivity does not have the strong effect on graduation that it has been credited with” (p. 930). However, academic selectivity may have influenced other student outcomes such as professional networks, subjective well-being, and future earnings (Heil et al., 2014). Underperforming

colleges that suffered from low graduation rates were largely driven by the composition of the student body and by low tuition revenue (Heil et al., 2014). High tuition rates indicated better college resources that promoted student success and also incentivized students to graduate because of the large investment (Heil et al., 2014). More important considerations in college selection such as favorable financing, proximity to family and social supports, the availability of programs, interested faculty, and personal preferences assisted students in selecting the right college (Heil et al., 2014).

The path from urban community colleges to four-year colleges was not successfully navigated by all students (Hagedorn, Cypers, & Lester, 2008). Academic focus and choice of appropriate course began the success of community college students aspiring to transfer (Hagedorn et al., 2008). Community colleges served a key role being, “an access bridge to other levels of postsecondary education” for transferring students (Hagedorn et al., 2008, p. 644). Despite low success rates of successful transfer and degree completion of community college students, these students expressed high academic goals (Hagedorn et al., 2008). Even with low-grade point averages (GPAs), low placement scores, modest success in developmental education, community college students aspired for graduate study (Hagedorn et al., 2008). The greatest barriers to successful transfer were convenient course schedules, lack of faculty connections, lack of information concerning transfer requirements, and poor academic advising (Hagedorn et al., 2008). Efforts to engage students in college life and to enjoy their experiences was beneficial, but these efforts must be paired with intensive academic support and consistent advising services for students to be successful (Hagedorn et al., 2008).

The achievement or opportunity gap was one of the major challenges that faced community colleges; a White population and an underrepresented minority population (Haberler

& Levin, 2014). The minority populations of Latino, Native American, African American, and undocumented students continued to succeed at a lower rate than their White, Asian, or more affluent peers in entering, persisting and completing community college programs (Haberler & Levin, 2014). Cohesion initiated and grounded by faculty where curriculum, instruction, faculty, and students are united together focused on the success of students (Haberler & Levin, 2014). The connection of all stakeholders was a key component for student success where connections occurred within colleges and outside colleges with local business and industry (Haberler & Levin, 2014). Structured interactions, like active curriculum and advisory committees, resulted in cooperation amongst student, faculty, administration (Haberler & Levin, 2014). Consistency at colleges that promoted regular interaction and collective events is the fourth and final conceptual condition for the success of students (Haberler & Levin, 2014). Cohesion, connection, cooperation, and consistency helped overcome the adversity of students with disadvantaged backgrounds and underrepresented minorities (Haberler & Levin, 2014).

In today's political and economic climate in America, community colleges are faced with the challenge of access and success, while operating under PBF policies. New student success metrics are vital to the livelihood of today's community colleges (Davidson, 2015). Leading indicators are metrics that indicate whether early student indicators or attributes give any indication of future academic success. Earning 30 credit hours by the end of the first year of college, passing a summer class, and completing a college-level English course are the three leading indicators positively correlated with successful transfer and associate degree completion (Davidson, 2015). Policymakers should use these leading indicators to adjust performance-based funding models to counteract any positive or negative gains in funding due to uncontrollable student demographics (Davidson, 2015). Davidson (2015) found that some pre-college factors,

such as being low-income and underprepared, were negatively correlated with completing an associate's degree or transferring and completing a bachelor's degree. Math developmental education interventions such as paired and compressed courses, summer bridge programs, and supplemental instruction result in greater than predicted student success (Davidson, 2015). Academic momentum or completing 30 credits by the first year, was the most significant predictor of degree completion in Davidson's findings, and students with 30 credits by the first year had 289% greater odds of completing an associate's degree or transferring (Davidson, 2015).

Cognitive growth, good learning orientations, and detailed graduation degree plans were elements successful students possess and experience according to (Cruce, Wolniak, Seifert, & Pascarella (2006). Other findings associated with positive outcomes include effective teaching and learning, interaction with peers, and challenge or high expectations had significant positive effects on students' overall attitude towards literacy and obtaining a college degree (Cruce et al., 2006). Chickering and Gamson's (1987) seven principles had a significant positive effect on the cognitive development, learning orientations, and educational aspirations of students, at least during the first year of college (Cruce et al., 2006).

If taken seriously, the research about the persistence of students in higher education could dramatically affect student success (Tinto, 1997). While changes have been made in student affairs (freshman year seminars, mentoring programs, bridge programs) over the past twenty years, the academic side of the house and the organization of higher education itself need to change (Tinto, 1997). Vincent Tinto added that "one thing we know about persistence is that involvement matters (Tinto, 1997). The more socially and academically students are involved, or the more students interact with faculty and other students, the more likely they are to persist

(Tinto, 1997). If students feel they are valued members of an institute of higher learning and have positive interactions, the more likely they will persist (Tinto, 1997). Experiences in academic settings in two-year colleges are vital to student persistence, so the challenge is to get students at two-year colleges to interact with other students and faculty (Tinto, 1997).

Involvements inside and outside the classroom have proven to positively correlate with increased student persistence especially at community colleges (Tinto, 1997). Shared, connected learning experiences, a distinct first-year unit, and faculty organized to work across the disciplinary and departmental borders that now divide them, are three steps for any institution of higher education to experience increased student persistence (Tinto, 1997).

Retention is vital to community college success, and student engagement is a key element for students to succeed. At all levels of higher education, orientation programs, specialized academic advisement, and student success initiatives have been modified across the country. Retention's primary elements are academic, tactical, and operational, yet areas like course registration are key to student success and retention (Bass & Ballard, 2012). Student retention is a primary gauge for assessing the success of students and the institution.

Student Social and Academic Integration

Community colleges have a unique mission in the United States' higher education system. Community colleges have an open-access mission, "which means they are the point of access for millions of students, including many from diverse backgrounds," and therefore enroll a larger percentage of minority and low-income students than the four-year universities (Tandberg et al., 2014, p. 3). With shorter commuting distances and shorter periods for degree completion, community colleges are more attractive to some students (Tandberg et al., 2014). Perhaps due to full-time work and being the first in their family to attend college, many

community college students place into remedial coursework and consequently have difficulties completing degrees. (Tandberg et al., 2014).

Social challenges. Community colleges have experienced growth in the adult learners population where these students are enrolled in flexible, fast-paced courses while balancing college, work, and family responsibilities (Noel-Levitz, 2011). As the adult population grows, community colleges will need to pay closer attention to the satisfaction these adults experience (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008; Noel-Levitz, 2011). According to Noel-Levitz (2011), “satisfaction assessment enables institutions to strategically and tactically target areas most in need of immediate improvement” (p. 2). It facilitated the growth and development of all major aspects of adult learner experiences to include their academics and student services (Noel-Levitz, 2011). Noel-Levitz (2011) reported that “research indicates institutions with more satisfied students have higher graduation rates, lower loan default rates, and higher alumni giving” (p. 2). Adult learners reported that outreach, financing, and life and career planning were most important to them while in college (Kuh et al., 2006; Kuh, 2007; Noel-Levitz, 2011). When specifically investigating enrollment factors, community college adult learners report that they value the availability of the program, the convenient time and place for classes, and lower cost the most (Noel-Levitz, 2011). Most importantly, colleges must survey their adult learners if they are going to be prepared to make informed decisions about academic and student services. (Noel-Levitz, 2011).

As globalization expands, community college leaders need to maintain an international perspective to understand various cultural values and synthesized world events. (Manns, 2014). The American community college must play a role in internationalizing and creating students who are not just citizens but global citizens. Global citizens that experienced international affairs

in the classroom, campus, and community to include learning the topics of international politics, the global economy, and international social movements (Manns, 2014). Manns (2014) suggested that “the recent focus on the internationalization of community colleges has the potential to dramatically change the role, scope, and mission of community colleges” (p. 707). Recent programmatic changes that directly result from internationalization include short and long-term travel abroad opportunities, international service learning projects, strengthened international partnerships, and student and or faculty exchanges (Manns, 2014). Students must have participated in international entrepreneurial experiences, developed through creative academic environments, which helped students to understand the global arena (Manns, 2014).

To improve upward social mobility and economic vitality to meet national goals, a corresponding improvement in degree outcomes for students who transfer from community colleges to universities must occur (Jenkins & Fink, 2016). Students who transfer from community colleges to universities were more than likely to be from lower-income homes than were students who entered higher education through four-year universities (Jenkins & Fink, 2016). According to Jenkins and Fink (2016), “the type of four-year institution that students transferred to was more important than the type of community college they transferred from” (p. 38). The income status of students matters; low-income students were less likely than higher income students to transfer to or earn a bachelor’s degree from a four- year university (Jenkins & Fink, 2016).

Community colleges serve as the entry point for over 40 percent of America’s undergraduates thus expanding our nation's postsecondary capacity (Jenkins & Fink, 2015). Students who enter community colleges intend to transfer and earn a bachelor’s degree while they enjoy lower tuition costs and an open-access mission (Jenkins & Fink, 2015). Vertical

transfer of community college students to four-year colleges provides a chance for upward mobility for underrepresented American populations (Jenkins & Fink, 2015). According to Jenkins and Fink (2015), “over 80 percent of community college students intended to earn at least a bachelor’s degree, However, only about a quarter end up transferring. Only 17 percent complete a bachelor’s degree” (p. 1). Of the 25 percent of students who do transfer to a four-year university, 62 percent go on to have earned a bachelor’s degree (Jenkins & Fink, 2015). According to Jenkins and Fink (2015), transfer shock, in the form of a lower GPA when transitioning to a university, does not seem to persist. “Students who transferred almost all of their community college credits were 2.5 times more likely to earn a bachelor’s degree than students who transferred fewer than half of their credits” (Jenkins & Fink, 2015, p. 3). Students who transferred with a two-year degree were 16 percent more likely to earn a bachelor’s degree than a student who transferred without one (Jenkins & Fink, 2015). Students who transferred in 2011 to a four-year college saved \$1.9 billion in tuition costs (Jenkins & Fink, 2015).

Student Assessment and Placement

For students to succeed in America’s community colleges, students’ assessment and placement realities have become increasingly important. Two necessities are evident when students succeeded in courses and programs: 1) completion of prerequisite courses and 2) proper assessment of students’ success (Academic Senate for California Community Colleges, 2014). Assessing students’ success in prerequisite courses is a fairly straightforward process for evaluating grades. However, “placing a student using assessment for placement process was necessarily more complicated, as such placements cannot be made based on assessment test scores alone” (Academic Senate for California Community, 2014, p.1). Some students may have difficulty in demonstrating necessary skills on a single placement test. “Limiting assessment to a

placement test, an exam with content and skills questions from several courses in a curricular sequence represents a single and potentially unsuitable measure of student preparation for college coursework” (Academic Senate for California Community, 2014, p.4). Placement exams, prior academic data, discipline experts, and college counselors have proven good elements of proper student placement (Academic Senate for California Community, 2014).

Proper placement of community college students by placing them in appropriate courses within programs is important for increasing student success (Collins, 2008). Properly designed placement policies include accurately assessing student skills and placing them in the needed courses, having consistent standards across colleges, and providing comparable data on student outcomes (Collins, 2008). By having clear placement assessment policies, college readiness of students has improved; by communicating these policies, the expectations are better understood by students (Collins, 2008). Having a good placement policy is not simply about a cut-off score, but includes the process of developing a common understanding of what college readiness means (Collins, 2008).

The National Assessment Governing Board (NAGB) conducted a comprehensive study in 2012 focused on the use of tests and cut-off placement scores. As students enter college, the first office they might have visited was an assessment office. Hughes and Scott-Clayton (2011) added that “often, placement is determined solely on the basis of whether a score is above or below a certain cutoff, although some students may be exempted by prior ACT, SAT, or high school exit examination scores” (p. 328). Placement tests have been commonly used as a “high-stakes determinant of students’ access to college-level courses (Hughes & Scott-Clayton, 2011, p. 328). The NAGB found the following tests are the most used nationwide, ACT, SAT, ACCUPLACER, ASSET, and COMPASS (Fields & Parsad, 2012). There is a consensus that

maintaining open access to community colleges and ensuring that students are meeting minimum standards for entry to college-level courses will have assisted in the nationwide student success movement (Hughes & Scott-Clayton, 2011). However, there are differing views on determining and implementing assessment and placement policy (Hughes & Scott-Clayton, 2011). Hughes and Scott-Clayton (2011) suggested that “placement recommendations that result from the use of these placement tests (COMPASS and ACCUPLACER) does not improve students outcomes (p. 344). Therefore a disconnect exists between the assessment and the intervention (Hughes & Scott-Clayton, 2011). “Seventy-one percent of postsecondary education institutions reported using some mathematics tests for determining the need for entry-level students for remedial courses in mathematics” (Field & Parsad, 2012, p. vi). “About half (53 percent) of postsecondary education institutions reported using some reading test for determining the need for entry-level students for remedial courses in reading” (Field & Parsad, 2012, p. vii).

The NAGB found that the majority of two-year and four-year institutions used placement tests to decide the need for students to take remedial math or English courses (Fields & Parsad, 2012). Only 13 percent of colleges reported using other elements than tests to determine placement (Fields & Parsad, 2012). The reported placement methods beyond tests were high school graduation, end of course tests, high school grades, highest mathematics or English courses taken, Advanced Placement or International Baccalaureate scores, and faculty recommendations (Fields & Parsad, 2012).

Using New York community college data, Belfield and Crosta (2014) conducted a study of the validity of high school data and placement tests for predicting college course grades. Belfield and Crosta (2014) found that “placement tests do not yield strong predictions of how students will perform in college” (p. ii). However, high school grade point average (GPA) is

useful in predicting college GPA and college credit accumulation (Belfield & Crosta, 2012). Assisting college leaders in placement of students would be other high school information such as the number of math and English courses taken, honors courses, the number of F grades, and the number of credits (Belfield & Crosta, 2012). According to Belfield and Crosta (2012), the accuracy of placement tests has severe error rates using cut-off test scores. The error rate for English was three out of ten students misassigned; math error rates are lower (Belfield & Crosta, 2012). Belfield and Crosta (2014) found that “using high school GPA instead of placements tests reduces the error rates by half across English and math” (p. ii).

The use of the new placement test (VPT) by the Virginia Community College System Office has shown promise for reducing the number of students placed in developmental education and for increasing the number of students completing college math (Rodríguez, 2014). In fall 2012, Rodríguez (2014) found a 24% higher placement rate into college math for first-time, first-year students using the VPT as compared with peers who used the COMPASS placement exam in the fall of 2010. The percentage of students who placed into and completed college math grew by 10% as the fall 2012 cohort progressed. (Rodríguez, 2014). “College leaders must plan accordingly for the increased number of students matriculating into college math that need extra support to earn a grade of C or higher” (Rodríguez, 2014, p. 3).

Placement tests are primarily used to group students into courses. However, studies have rarely focused on the use of placement tests to inform instructional decisions (Green & Weir, 2004). Green and Weir (2004) used the Global Placement Test (GPT), a measure of grammatical knowledge, to accurately measure student mastery of grammatical structures and guide diagnostic intervention. Contrasting their findings with prior research, Green, and Weir (2004)

“cannot, therefore, support the use of the GPT to inform instruction” (p. 487). However, the GPT has estimated students’ ability in grammar across contexts (Green & Weir, 2004).

Using placement tests to place students in developmental or college level courses appropriately is an area of concern for community college leaders. According to Armstrong (2000), “the increasing use of placement tests to group students by ability has led to legal challenges from groups concerned with testing practices and safeguarding open access” (p. 682). One challenge to community colleges has been demonstrating that using placement tests to group students enhanced their likelihood of success in a course (Armstrong, 2000). Students varied characteristics made predicting success in community college courses more difficult (Armstrong, 2000). Armstrong (2014) added that “sorting students by using cutoff scores on a test may mask important individual student characteristics and situations” (p. 682). “The predictive validity of test scores with respect to final grade is difficult to establish” (Armstrong, 2000, p. 691). Achieving a strong correlation was difficult “due to the differing characteristics and backgrounds of students and differences in the grading practices of individual instructors” (Armstrong, 2000, p. 691).

Many students entering college are not ready for college-level courses even though they may have completed college preparatory courses in high school (Bailey & Jaggars, 2016; Cohen et al., 2013; Hoyt & Sorensen, 2001). Hoyt and Sorensen (2001) found that “over half the students who completed high school intermediate algebra and geometry have test scores that placed them in remedial math courses at the college” (p. 26). “More than a third of the students successfully completing 12th grade English had test scores that placed them in remedial English” (Hoyt & Sorensen, 2001, p. 26). Many students demonstrate success in high school and then place in remedial work in college. Concerns regarding the rigor of high school programs became

more frequent (Hoyt & Sorensen, 2001). Hoyt and Sorenson (2001) advocated for further collaborative efforts between high school and colleges to improve the preparation of students. Possible solutions could be college professors assisting in developing the high school curricula and earlier, more intrusive, interventions in the middle school years of lower academic performing students (Hoyt & Sorensen, 2001).

Developmental Education and Remediation

Many students who begin at community colleges are not college ready and enter an extensive developmental education process. When students enter developmental education, they may enroll in as many as five levels of non-credit remedial courses (Bailey & Cho, 2010). “About 60 percent of incoming students are referred to at least one developmental course. Being referred to developmental education was often surprising to them since the large majority of community college entrants are high school graduates” (Bailey & Cho, 2010, p. 1). Numerous students who may have completed one course never continued to the next course in the sequence, nor do many students complete the sequence (Bailey, 2009a). “Many students who are referred to developmental never enroll in it” (Bailey, 2009, p. 24). Further complicating the success picture of developmental education is the lack of what constitutes being college ready, use of different assessments and cut scores, and different levels of support for struggling college level students (Bailey, 2009).

Older students, Black students, part-time students, and vocational students are less likely than their peers to progress through their sequence of remedial courses (Bailey et al., 2008). There are institutional characteristics such as curriculum, faculty expertise, and financial ability that are also related to a lower probability of sequence completion.

For students to earn a degree, persisting beyond developmental mathematics is critical (Davidson & Petrosko, 2015). Academic ability, coupled with work and family factors, was the most statistically significant predictors of developmental math persistence in a study by Davidson & Petrosko (2015). Students who took a developmental math course in person with an online component were about one and a half times more likely to persist than students who took the course in person. Age was statistically significant; the older you were, the more likely a student became to complete remedial math (). And, when parents' adjusted gross income increased, the likelihood of student persistence increased (Davidson & Petrosko, 2015).

Many community colleges in America are exploring accelerated developmental math programs with the intent of increased student outcomes. The accelerated model allowed students to enroll in remediation courses and college-level coursework within a shorter time frame. A typically accelerated program may have combined two of three remedial courses into a one-semester experience. The next semester students enroll in college-level coursework (Jaggars et al., 2015). However, there is concern that the lowest developmental students would not benefit from an accelerated program; the lowest-achieving students would have performed better in a traditional semester-by-semester sequence of remedial courses (Jaggars et al., 2015). "Overall, we find that accelerated developmental education provided students with a strong positive boost regarding their probability of enrolling in and completing college-level math and English" (Jaggars et al., 2015, p. 20). To have maintained successfully accelerated pathways, colleges needed to incorporate rigorous content provided systematic faculty development and enlisted targeted student supports (Jaggars et al., 2015).

At the turn of the current century, many states assigned the responsibility for remedial education to their community college system (Bailey et al., 2015; Bettinger & Long, 2005;

Cohen et al., 2013). As of 2005, New York, Arizona, Florida, South Carolina, Montana, and Virginia, all have policies that prohibit four-year colleges and universities from offering remedial education (Bettinger & Long, 2005).

One of the most important topics for community college faculty is how to help developmental students succeed. There is a great need for an in-depth conversation among community college faculty about how to best serve these students. LaGuardia Community College took part in a grant from the Kresge Foundation that funded the creation of an online professional development project called, Taking College Teaching Seriously (Khoule, Pacht, Schwartz, & van Slyck, 2015). The project was designed to enhance teaching and learning for both full and part-time faculty teaching developmental math and English, based on the hypothesis that as faculty becomes more attuned to the impact of the pedagogical choices, their improved understanding will have a significant impact on student retention and success (Khoule et al., 2015). Faculty worked in an asynchronous online environment in small pedagogy circles, assisted by a coach, posting lesson descriptions, reflections, and assessments (Khoule et al., 2015). “This reflective, collaborative process enables faculty involved to learn more about their own and each other’s teaching in a sustained community of practice (Khoule et al., 2015, p. 40).

When examining North Carolina’s community colleges, researchers found that being required to take a remedial course (as we define it in this article) either in math or in English significantly reduces a student’s probability of success in college and also the probability that a student ever passes a college-level math or English course.

(Clotfelter, Ladd, Muschkin, & Vigdor, 2015)

However, for students who took a remedial course in their first semester, there are no adverse effects on the probability of returning for another semester (Clotfelter et al., 2015). There

were differential effects by a student's prior academic achievement level, family income, and gender. (Clotfelter et al., 2015). The conclusion of a better developmental education program in North Carolina was to assist traditional age community college students assuring they gain the necessary skills while they are still in high school (Clotfelter et al., 2015).

The findings of a study by Benken, Ramirez, Li, & Wetendorf (2015) suggested neither that the number of years of high school math courses nor the passing math courses in high school prepared students for the academic rigor of college-level courses. Results indicated that a student's attitudes about mathematics were a better indicator of college-level math success (Benken, Ramirez, Li, & Wetendorf, 2015). Success was defined as students earning a course grade of "C" or higher. (Benken et al., 2015). Benken et al. (2015) suggested "in order to improve student success within developmental mathematics programs; we needed a detailed picture of who these students are, both regarding their mathematical preparation and affect" (p. 14). For example, did students possess the essential skills to be successful in college-level math and did students have negative attitudes and anxiety towards mathematics.

Problem and Purpose Statements and Research Questions

Out of this environment of scholarly inquiry, there appears to emerge the vacancy of research exploring the relationships of co-enrollment of remedial math coursework and college-level math student success. Filling this vacancy is important due to less than half of the students that begin developmental education complete it (Bahr, 2010, 2012; Bailey et al., 2015). Unfortunately, ever fewer students that begin developmental education graduate with a degree (Bahr, 2010, 2012; Bailey et al., 2015).

The purpose of this study was to conduct a rigorous examination of co-enrollment of students in math remediation and college-level math. A quasi-experimental, posthoc design

examined the outcomes and the relationships of two groups of students who participated in a pilot project the goal of which was to assess the co-enrolled model that is designed to provide students with mathematics support. One group of students enrolled in a traditional model of developmental mathematics. The second group of students co-enrolled in developmental and college-level math.

Therefore, the goal of this present study is to ascertain answers to the following research questions:

1. For students in the two groups of community college students in the sample under study, is there a difference in the completion of developmental math courses by the end of the spring 2017 semester?
2. Is there a difference in the completion of college-level math courses by students in the two groups by the end of the spring 2017 semester?
3. For the two groups in the study, is there a difference in the grades of students in their college-level math courses by the end of the spring 2017 semester?
4. For the students in the sample, is there a difference in the number of credits that students completed by the end of the spring 2017 semester?
5. Is there a difference in the completion by students in developmental math courses by college type, using the criteria of rural and urban?

CHAPTER 3

Methodology

Introduction and Goals of the Study

The literature review provided in the previous chapter produced co-requisite math remediation as a potential path for students to complete college-level math more successfully (Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015). The most relevant research added that in the United States, almost two-thirds of incoming community college students were not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey et al., 2015; Jaggars & Hodara, 2013). The incoming student population was less exclusive than in the past, resulting in heterogeneity of the student population (Bettinger & Long, 2005; Goldrick-Rab & Cook, 2011). Colleges addressed the unplanned developmental math population growth of more students not being college ready with extensive developmental education programs. (The terms developmental and remedial are used interchangeably in this study.) The purpose of developmental education programs was to provide students with weak academic skills with the opportunity to strengthen those skills and thus to prepare them for college-level coursework (Bailey et al., 2010; Bettinger & Long, 2005). But, less than half of the students who began developmental education in the U.S. complete the course or courses in which they are placed, and were 11% less likely to complete a two-year degree within three years (Bahr, 2010, 2012; Bailey et al., 2015; Bettinger & Long, 2005).

Providing remediation for unprepared entering students was one of the greatest challenges to America's community colleges. Community college students struggled to progress through the current model of developmental math coursework (Bailey et al., 2015; Jaggars & Hodara, 2013; Scott-Clayton & Rodriguez, 2012). Students were not progressing through

developmental math, and subsequently not completing college-level math. Consequently, students did not graduate with a degree or a certificate or transfer to a four-year university. Perhaps students who co-enrolled in developmental math with college-level math or co-requisite remediation will achieve greater success or better grades in their college-level math courses. Therefore the goals of this present study were to ascertain answers to the following research questions:

1. For students in the two groups of community college students in the sample under study, is there a difference in the completion of developmental math courses by the end of the spring 2017 semester?
2. Is there a difference in the completion of college-level math courses by students in the two groups by the end of the spring 2017 semester?
3. For the two groups in the study, is there a difference in the grades of students in their college-level math courses by the end of the spring 2017 semester?
4. For the students in the sample, is there a difference in the number of credits that students completed by the end of the spring 2017 semester?
5. Is there a difference in the completion by students in developmental math courses by college type, using the criteria of rural and urban?

Research Design

A quasi-experimental, posthoc design was used for this study. Leedy and Ormrod (2016) defined research as the “systematic process of collecting, analyzing, and interpreting information to increase our understanding of a phenomenon about which we are interested” (p. 2). Therefore, this study described the process of collecting data, analyzing data, and interpreting results with

the ultimate goal to increase the understanding of the Phenom of co-requisite math remediation of a sample of students in a U.S. Southeastern state's community colleges.

By using a quasi-experimental, posthoc research design, this study examined differences between developmental only math and co-enrolled college-level math. A cause and effect relationship was important to this study, but seeking absolute truths proved difficult and was not possible with a quasi-experimental design, and therefore the post-positivist research paradigm was used (Leedy & Ormrod, 2016). "Post-positivists believe that true objectivity in seeking absolute truths can be an elusive goal" (Leedy & Ormrod, 2016, p. 7). Researchers had biases and made objectivity in the collection and interpretation of data more difficult (Leedy & Ormrod, 2016). By using the post-positivist paradigm, this study hypothesized that the probability that co-requisite remediation was better at getting students through college-level math than the traditional model of developmental education first, then college-level math.

Through the use of statistical data analysis, answers to the research questions did occur. Therefore, a quantitative research methodology was more appropriate to analyze statistical data than a qualitative research methodology (Leedy & Ormrod, 2016). The purpose of this proposed quantitative study was to seek explanations that will generalize to other research. This study intended to "identify relationships among two or more variables and then, based on the results, to confirm or modify existing theories or practices" (Leedy & Ormrod, 2016, p. 80).

A posthoc design proved most beneficial for this proposed study. A true experiment where students had random placement in traditional remedial education, co-requisite remediation, or college-level coursework was not feasible in a state-wide community college system. Students typically entered a community college, took a placement test, and enrolled in courses based upon the score of the placement test as well as work and family schedules (Bailey

et al., 2015; Cohen et al., 2013). Therefore, the posthoc design allowed investigation of the extent to which specific independent variables affected the dependent variables (Leedy & Ormrod, 2016). In a posthoc design, conditions were already in place or events have already happened, and then data collection took place investigating a possible relationship between variables (Leedy & Ormrod, 2016). “Ex post facto research involves looking at existing circumstances with clearly identifiable independent and dependent variables” (Leedy & Ormrod, 2016, p. 194). Since direct manipulation was not possible, the results could not draw clear conclusions about cause and effect (Leedy & Ormrod, 2016). Leedy and Ormrod (2016) argued that “the problem here is the experimenter can’t control for confounding variables that might provide alternative explanations for any group differences observed” (p. 194). Researchers agreed that even with the lack of controlling the independent variable the ex-post facto research design was legitimate (Leedy & Ormrod, 2016).

Specifically, a simple posthoc design was the design used for this study. The important difference between the simple posthoc design and a true experiment was timing (Leedy & Ormrod, 2016). The treatment happened long before this proposed study took place and therefore was called an experience rather than treatment (Leedy & Ormrod, 2016). In a simple posthoc design, one group had experienced the treatment while the other group had not. According to Leedy and Ormrod (2016), a simple posthoc research design concluded that “certain behaviors tend to have an association with certain pre-existing conditions, and we could never have determined that any variables were caused by those conditions” (p. 195).

Grouping students would have strengthened this proposed study’s simple posthoc design. Students groups were analyzed using students’ demographic comparison variables, such as the number of developmental math modules taken prior to the Fall 2016 semester, financial aid

status (yes/no), enrollment (part-time/full-time), first-generation status (yes/no), race (white/non-white), age (≤ 25 , 26-40, 41+), gender (male, female) and type of college (rural/urban). The student groups were developmental only and co-enrolled developmental. Nine of a U.S. Southeastern state's community colleges participated in the pilot project during the 2016 – 2017 academic year. The results of the analysis of student group demographics suggested that the groups were similar without attempting to have the same number in each. Furthermore, all student data were utilized.

Research Study Description

After receiving approval from the university's Institutional Research Board (IRB) (Appendix A), the proposed research project employed a non-experimental design, due to lack of random assignment to student groups. A quasi-experimental, posthoc design supported the literature review, the research questions, and the hypothesis.

Participants and Site

All students that entered a program of study at a U.S. Southeastern state's Community College System which required a math or English course must satisfy placement requirements for these courses (VCCS, 2017). Placement was determined by an acceptable GED, SAT, or ACT score. Transfer students submitted a transcript for review and placement (VCCS, 2017). Students who did not satisfy placement requirements by the metrics mentioned above were required to take the Placement Test in math and English (VCCS, 2017).

The population of interest for this study was degree and certificate-seeking community college students. Many students attended a community college for reasons other than to attain a degree (Cohen et al., 2013). The non-degree seeking students typically did not enroll in an official program of study, did not take a placement exam, are not placed into developmental

education, and may not have taken a math or English course (Bailey et al., 2015; Cohen et al., 2013). Therefore, degree and certificate-seeking students were the most applicable student demographic to include in this study.

The sample was drawn from the nine pilot colleges that volunteered to be a part of the System Office pilot project. The population size for group one was 7408 students and 208 for group two. The process used to select the participants was purposive sampling. Leedy and Ormrod (2016) defined purposive sampling as “choosing people or units for a particular purpose” (p. 165). For the academic year 2016-2017, that included the Fall 2016 and Spring 2017 semesters, the year long, longitudinal dataset, used purposive sampling, all students who took developmental education were in one group. All students who enrolled in co-requisite remediation were in the second group.

Data Collection

After approval was received from the Old Dominion University’s IRB, the data request was made to the System Office. The System Office required a written request submitted to the Assistant Vice Chancellor for Institutional Effectiveness. After receiving approval from the System Office, the actual data collection process occurred. Personal identifiers were removed from the dataset to ensure anonymity of the participants.

The dependent variables were grades and completion of the first credit math course. The independent variables were traditional developmental math grades and co-requisite remediation grades. The comparison variables were, the number of developmental math modules taken prior to the Fall 2016 semester, financial aid status (yes/no), enrollment (part-time/full-time), first-generation status (yes/no), race (white/non-white), age (≤ 25 , 26-40, 41+), gender (male, female) and type of college (rural/urban).

Further classification of the variables aided in the data analysis of this proposed research project. Variable classification occurred as continuous variables or discrete variables and nominal data or ordinal data (Leedy & Ormrod, 2016). Continuous variables “reflected an infinite number of possible values falling along a particular continuum” (Leedy & Ormrod, 2016, p. 219). Discrete variables “had a finite and small number of values” (Leedy & Ormrod, 2016, p. 219). Nominal data are “those for which numbers were used only to identify different categories of people, objects, or other entities” (Leedy & Ormrod, 2016, p. 219). Ordinal data were “those for which the assigned numbers reflect an order or sequence” (Leedy & Ormrod, 2016, p. 219). College-level math grades, traditional developmental math grade performance, and co-requisite math grade performance were all discrete and nominal. Gender, age, enrollment status, financial aid status, and first-generation status were all discrete and nominal.

Data Analysis and Reporting

According to Leedy and Ormrod (2016) “all research requires logical reasoning,” and quantitative research usually used deductive reasoning (p. 81). Quantitative researchers began with certain premises, hypothesis or theories, and then formed logical summaries from them (Leedy & Ormrod, 2016). By maintaining objectivity in data analysis, quantitative researchers used predetermined statistical procedures and objective criteria to formulate the results of those procedures (Leedy & Ormrod, 2016).

Descriptive statistics analysis that utilized frequency and crosstabulation tools, logistic regression, and ANOVAs were used for the data analysis (Field, 2013). College-level math grade performance was the dependent variable (DV), and traditional developmental math grades, and co-requisite math grade performance were the independent variables (IV). The comparison

variables were gender, age, ethnicity, enrollment status, credits completed by Spring 2017, financial aid status, and first-generation status.

The combination of descriptive statistics and robust analyses of regressions was used to develop this study. IBM's SPSS program was used to perform the analyses. After the analyses were complete, the interpretation of the results occurred. Quantitative researchers typically described their findings in statistics such as mean, median, correlation coefficients, and statistical significance (Field, 2013; Leedy & Ormrod, 2016). A detailed, narrative analysis of the results was typically reported using formal, scientific style with impersonal language (Field, 2013; Leedy & Ormrod, 2016).

Data Quality

The two concepts of internal and external validity originated in early discussions of experimental research (Campbell & Stanley, 1971). Internal validity referred to the extent which a study's design and data yield conclusions on cause and effect relationships (Campbell & Stanley, 1971; Leedy & Ormrod, 2016). When conducting true experimental designs, internal validity was of major concern. However, the ex-post facto design was not a true experimental design (Campbell & Stanley, 1971; Hays & Singh, 2012; Leedy & Ormrod, 2016). Therefore, internal validity would not be a major concern. External validity referred to the extent where the results of one study can be generalized to other contexts (Campbell & Stanley, 1971; Hays & Singh, 2012; Leedy & Ormrod, 2016). This study used the external validity strategies of a real-life setting and a representative sample. The source of the data was the System Office database.

Reliability was the "consistency with which a measurement instrument yields consistent results" (Leedy & Ormrod, 2016, p. 98). Interrater reliability and test-retest reliability were two strategies to strengthen this proposed research study. Two different researchers ran the data

analyses, at different times, to ensure interrater reliability. The student researcher ran the data analyses several different times to ensure test-retest reliability.

Limitations and Delimitations

This quantitative, ex-post facto research design had several limitation and delimitations. There was no direct manipulation of the independent variable, therefore deeming this research as non-experimental (Leedy & Ormrod, 2016). Due to the lack of manipulating an independent variable, the researcher could not control for confounding variables that might have provided insight into any group difference observed (Leedy & Ormrod, 2016). Additionally, an ex-post facto research study could never have definitively determined the relationships among variables (Leedy & Ormrod, 2016). Additional data, such as placement test scores, would have been beneficial to this study to have examined the relationship of placement test scores and college-level math success.

The delimitations of this research design included using additional data of students throughout the United States instead of only one state's data. Using only one U.S. Southeastern state's data, the findings from this proposed study could not be generalized to other states. The data range was only for one academic year. Using data from a ten-year range or all 23 System Office Community Colleges would have increased the validity of the study. Confounding variables such as high school GPA and highest high school math course completed could be added to strengthen the study.

Summary

Developmental education was one of the greatest challenges to America's community colleges. However, co-requisite remediation may have been the answer for many students who struggle with the traditional model of developmental education. Using a quasi-experimental,

posthoc research design, with data from nine System Office colleges, the research study responded to the posed research questions concerning co-requisite remediation and college-level math.

CHAPTER 4

Analysis of the Data

The primary purpose of this study was to determine if co-enrolled students have higher completion rates, as measured by their grades in developmental and college-level math courses than their peers who took developmental and college-level math courses separately. The research was designed to enable an examination of differences in the data describing students' grades in developmental and college-level math courses. This study also examined the question - did students who co-enrolled in developmental and college-level math earn more credits by the end of the spring 2017 semester than their peers who took developmental and college-level math separately. The completion rates of students in developmental math courses in rural and urban colleges were also analyzed.

Characteristics of the Sample

The sample for this study ($N = 10,592$) comprised students from nine community colleges in a southeastern state. Students were selected for this study who co-enrolled in developmental and college-level math courses and other students who took developmental and college-level math separately during the fall 2016 and spring 2017 semesters. Group one, or the comparison group, consisted of students who took developmental and college-level math separately in either semester. Group two, or the treatment group, was drawn from students who co-enrolled in developmental and college-level math in either semester. To reduce the effects of any learned behaviors, such as prior enrollment in developmental math courses before the fall 2016 semester, these students were removed from the sample. The resulting sample size was ($N = 7,616$) total students. There were ($n = 7408$) students in developmental math only and ($n = 208$) students in co-enrolled math.

Crosstabulations and frequencies were run between comparison and co-enroll using student demographics to determine the differences in the two groups under study. The number of college-level credits completed by the end of spring 2017 semester was presented in Table 1. As reported in Table 1, the developmental only students had a mean score of 42.09 credits ($SD = 26.10$, $N = 7408$) by the Spring 2017 semester. The co-enrolled developmental students had a mean score of 37.62 credits ($SD = 24.41$, $N = 208$) by the Spring 2017 semester. A univariate, one-way ANOVA found that total number of credits earned by the spring 2017 semester the relationship was statistically significant $F(1, 7616) = 5.96$, $p = .015$. Those in developmental only took significantly more credits than those who were co-enrolled.

Table 1

Students' Number of Credits by Spring 2017

Group	<i>M</i>	<i>SD</i>	<i>N</i>
Developmental Only	42.09	26.10	7408
Co-enrolled Developmental	37.62	24.42	208

$p = .015$

Table 2 depicted the analysis of the two groups using a univariate, one-way ANOVA on the number of credits taken Spring 2017 did not vary between the two groups $F(1, 7616) = .60, p = .437$. Developmental only students took an average of 9.32 credits ($M = 9.32, SD = 4.19$) and co-enrolled students took an average of 9.09 credits ($M = 9.09, SD = 4.12$).

Table 2

Students' Number of Credits Taken Spring 2017

Group	<i>M</i>	<i>SD</i>	<i>N</i>
Developmental Only	9.32	4.19	7408
Co-enrolled Developmental	9.09	4.12	208

$p = .437$

The crosstabulation of financial aid status was listed below in Table 3. Financial aid status was categorized as students who did or did not receive a federal Pell Grant. The percentage of developmental only students who received Pell Grants was 47.88%, while 49.04% of co-enrolled students obtained a Pell Grant award. The two groups had similar percentages of students that were awarded a Pell Grant, therefore, adding to the assumption that the two groups did not have statistically significant differences.

Table 3

Students' Financial Aid Status, Pell Grant or No Pell Grant

Group	Pell	No Pell	Total
Developmental Only	3547 47.88%	3861 52.12%	7408
Co-enrolled Developmental	102 49.04%	106 50.96%	208

Enrollment crosstabulations were reported in Table 4. Students were full-time students if they took 12 or more credits in a semester or part-time students if they took 11 or fewer credits in a semester. Full-time students comprised 37.86% of the population of the comparison group. The enrollment status of the experimental group was similar with 35.10% of its students were classified as full-time. The two groups were similar in full-time and part-time status.

Table 4

Students' Enrollment Status

Group	Full Time	Part Time	Total
Developmental Only	2805 37.86%	4603 62.14%	7408
Co-enrolled Developmental	73 35.10%	135 64.90%	208

The first generation status crosstabulation data was reported in Table 5. For this study, first-generation was defined as students whose parents never earned a baccalaureate degree. As with other demographic variables, the two groups were similar. Approximately two-thirds of group one students who were categorized as first-generation students and slightly less group two students were categorized as first-generation.

Table 5

Students' First Generation Status

Group	Yes	No	NA	Total
Developmental Only	4972 67.12%	2430 32.80%	6 0.08%	7408
Co-enrolled Developmental	135 64.90%	73 35.10%	0 0%	208

Race crosstabulation data were listed in Table 6. Students were categorized as white or Caucasian if they identified themselves as white and non-white for all other students. Developmental only students consisted of 52.04 % of white students and 48.56% of the co-enrolled students identified as white.

Table 6

Students' Ethnicity Status

Group	White	Non-white	Total
Developmental Only	3855 52.04%	3553 47.96%	7408
Co-enrolled Developmental	101 48.56%	107 51.44%	208

The crosstabulation age data were listed below in Table 7. For this study ages were categorized as follows: 25 years and younger, 26 – 40 years old, and students 41 years old and older. Group one had 62.80 % of its student who was 25 years old or younger, 28.31% of its students were between the ages of 26 and 40, and 8.90% of the group was 41 years of age or older. Group two had 55.77% of its students who were 25 years old or younger, 34.62 of its students were between the ages of 26 and 40, and 9.62% of its students were 41 years old or older.

Table 7

Students' Age

Group	<=25	26-40	41+	Total
Developmental Only	4652 62.80%	2097 28.31%	659 8.90%	7408
Co-enrolled Developmental	116 55.77%	72 34.62%	20 9.62%	208

Results of a univariate, one-way ANOVA indicated, in Table 8 below, that the two groups were similar in age, $F(1, 7616) = 2.25, p = .134$. Descriptive statistics showed that the developmental only student group ($M = 26.69, SD = 8.60$) and the co-enrolled student group ($M = 27.60, SD = 8.98$) were similar.

Table 8

Students' Age

Group	<i>M</i>	<i>SD</i>	<i>N</i>
Developmental Only	26.69	8.60	7408
Co-enrolled Developmental	27.60	8.98	208

$p = .134$

Table 9 depicted the students' crosstabulation gender data. This study categorized students as male, female, or unknown. The unknown category was data that was empty when accessed. The comparison group was 47.89% male, and 52.47% female with 0.04% of the data left blank. The experimental group was 41.83% male and 58.17% male with no blank data.

Table 9

Students' Gender

Group	Male	Female	Unknown	Total
Developmental Only	3518 47.49%	3887 52.47%	3 0.04%	7408
Co-enrolled Developmental	87 41.83%	121 58.17%	0 0.00%	208

The rural or urban classification of cross-tabulation data were found in Table 10. This study used the System Office Rural Horseshoe Initiative Data to classify the nine colleges as either rural or urban. Colleges were classified as either rural or urban based on educational attainment, income level to meet monthly expenses, unemployment rates, and healthy or unhealthy jurisdictions. There were five colleges classified as rural and four colleges classified as urban. The percentage of students in the comparison group who attended rural community colleges was 20.72%; 79.28% of this group attended urban colleges. The percent of the experimental group who attended rural campuses was 19.71%; 80.29% attended campuses in an urban setting.

Table 10

Participants Attending Campuses in Rural or Urban Areas

Group	Rural	Urban	Total
Developmental Only	1535 20.72%	5873 79.28%	7408
Co-enrolled Developmental	41 19.71%	167 80.29%	208

Evaluation of the Groups

After careful analysis of the demographic data analyzed in Tables 1 through 10 used to identify the students in the comparison and treatment groups, this researcher determined that there were no significant demographic differences in the two groups other than on the dependent variables of interest. Therefore all co-enrolled students ($n = 208$) and all developmental only students ($n = 7408$) were used to answer the five stated research questions. All students ($N = 7616$) in the sample did not take any developmental or college-level math courses before the fall 2016 semester, therefore, reducing any learned behaviors such as other developmental math courses.

Presentation of the Research Findings

The purpose of this study is a rigorous examination of co-enrollment of students in math remediation and college-level math. The research questions that guided this study were as follows:

1. For students in the two groups of community college students in the sample under study, is there a difference in the completion of developmental math courses by the end of the spring 2017 semester?
2. Is there a difference in the completion of college-level math courses by students in the two groups by the end of the spring 2017 semester?
3. For the two groups in the study, is there a difference in the grades of students in their college-level math courses by the end of the spring 2017 semester?
4. For the students in the sample, is there a difference in the number of credits that students completed by the end of the spring 2017 semester?

5. Is there a difference in the completion by students in developmental math courses by college type, using the criteria of rural and urban?

Developmental math course completion. I investigated if there was a difference for students in the developmental only and co-enrolled groups in the completion of developmental math courses by the end of the spring 2017 semester. The analysis found that co-enrolled development students completed 74.04% of their developmental math courses while their peers who took developmental math separate from college-level math completed 43.35% of their courses. Students who earned a grade of A, B, C, D, or S were categorized as complete. Students who earned a grade of F, I, R, W, or U were categorized as did not complete. Students that chose to audit the course or had no grade data, but are enrolled, were categorized as unknown. Data were reported in Table 11.

Table 11

Students' Developmental Math Course Completion

Group	Complete	Did Not Complete	Unknown	Total
Dev. Only	3211 43.35%	4139 55.87%	58 0.78%	7408
Co-enrolled Dev.	154 74.04%	48 23.07%	6 2.89%	208

A binomial logistic regression was performed to ascertain the relationship of students' taking developmental only courses or co-enrolled developmental courses on the likelihood that participants completed their developmental courses. The relationship of developmental only and co-enrolled students with their developmental math course completion was statistically significant, $\chi^2(1) = 86.22, p < .001$. The model explained 15.0% (Nagelkerke R^2) of the variance in completing developmental math courses and correctly classified 56.8% of cases. Sensitivity was 4.6%, specificity was 98.9%, positive predictive value was 76.2%, and negative predictive value was 52.3%. The predictor variable was statistically significant, type of developmental course (Table 12). Co-enrolled students had 4.13 times higher odds to pass their developmental math course than developmental only students.

Table 12

Logistic Regression Predicting Likelihood of Developmental Math Course Completion

	<i>B</i>	SE	Wald	<i>df</i>	<i>p</i>	Odds Ratio
Course Type	1.42	.17	72.19	1	<.001	4.13
Constant	-.253	.02	115.61	1	<.001	.77

A second binomial logistic regression was performed to analyze the relationship of age, gender, urban or rural community college attended, ethnicity, first-generation status, number of credits taken that term, or Pell Grant or no Pell Grant, on the likelihood that participants

complete their developmental courses. The relationship of developmental only and co-enrolled students with the independent variables on developmental math course completion was statistically significant, $\chi^2(8) = 157.61, p < .001$. The model explained 28.0% (Nagelkerke R^2) of the variance in completing developmental math courses and correctly classified 57.4% of cases. Sensitivity was 17.2%, specificity was 89.8%, positive predictive value was 57.6%, and negative predictive value was 42.6%. Of the seven predictor variables, three were statistically significant: age, number of credits, and Pell Grant status, (as shown in Table 13). Co-enrolled students were more than four times more likely to complete than those students who enrolled in a developmental course that was separate from a credit-bearing math course. This result was found to be statistically significant at the $p = <.001$ level.

According to these findings, increases in age had a minimal increase ($OR = 1.02$) in the likelihood of passing a developmental math course. Number of credits was nearly even with an odds ratio of 0.99. Having a Pell Grant slightly decreased the odds ($OR = .90$) of passing a developmental math course. Not statistically significant but, females had a minimal increase in the likelihood ($OR = 1.05$) of passing a developmental math course compared to males. Even though not significant, students at a rural college were more likely ($OR = 1.09$) to complete a developmental course than those at an urban college. First generation status was nearly even with an odds ratio of 0.99. Being non-white slightly decreased the odds ($OR = .92$) of passing a developmental math course.

Table 13

Logistic Regression Predicting Likelihood of Developmental Math Course Completion Based on Age, Sex, Urban or Rural, Ethnicity, First-generation Status, Number of Credits Taken That Term, or Pell Grant or No Pell Grant

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>df</i>	<i>p</i>	<i>Odds Ratio</i>
Course Type	1.41	.17	71.17	1	<.001	4.11
Age	0.19	.01	43.17	1	<.001	1.02
Sex(1)	0.53	.05	1.20	1	.274	1.05
Urban or Rural(1)	0.87	.06	2.01	1	.156	1.09
Ethnicity(1)	-0.09	.05	2.93	1	.087	0.92
First Gen.(1)	-0.01	.05	0.00	1	.987	0.99
Credits	-0.01	.01	5.37	1	.021	0.99
Pell Grant(1)	-0.11	.05	4.55	1	.033	0.90
Constant	-0.57	.12	22.40	1	<.001	0.57

College-level math course completion. The following research question aimed to analyze college-level math course completion. Is there a difference in the completion of college-level math courses by students in the two groups by the end of the spring 2017 semester? Cross-tabulation descriptive statistics were used to produce Table 14. Developmental only students completed at a rate of 9.63% while co-enrolled students completed at a rate of 75.48%. Students who earned a grade of A, B, C, or D, were categorized as complete. Students who withdrew or

earned a grade of F were categorized as never complete. Students who did not enroll in a college-level math course in the Fall 2016 or Spring 2017 semesters were categorized as never attempt.

Table 14

Students' College-level Math Course Completion

Group	Complete	Never Complete	Never Attempt	Total
Dev. Only	713 9.63%	278 3.75%	6417 86.62%	7408
Co-enrolled Dev.	157 75.48%	51 24.52%	0 0.00%	208

A binomial logistic regression was performed to ascertain the relationship of students' course type on the likelihood that participants completed their college-level math courses. (See Table 15). The relationship of college-level math course completion and developmental only or co-enrolled was not statistically significant, $\chi^2(1) = 1.59, p = .212$. However, the model explained 2.0% (Nagelkerke R^2) of the variance in completing developmental math courses and correctly classified 72.7% of cases. Sensitivity was 4.6%, specificity was 98.9%, positive predictive value was 72.7%, and negative predictive value was 0.00%. The predictor variable was not statistically

significant, type of developmental course (as shown in Table 15). Co-enrolled developmental students had 1.25 times higher odds to pass their course than developmental only students.

Table 15

Logistic Regression Predicting Likelihood of College-level Math Course Completion

	<i>B</i>	SE	Wald	<i>df</i>	<i>p</i>	Odds Ratio
Course Type	.224	.18	1.55	1	.213	1.25
Constant	.942	.07	177.43	1	<.001	2.57

$p = .212$

A second binomial logistic regression was performed to obtain the relationship of age, sex, urban or rural, ethnicity, first-generation status, number of credits taken that term, or Pell Grant or no Pell Grant, on the likelihood that participants completed their college-level math in Table 16. The relationship of course type on college-level math course completion was not statistically significant, $\chi^2(8) = 14.57, p = .068$. However, the model explained 18.0% (Nagelkerke R^2) of the variance in completing college-level math courses and correctly classified 72.7% of cases. Sensitivity was 100.0%, specificity was 0.0%, positive predictive value was 72.7% and negative predictive value was 0.0%. Co-enrolled developmental students had 1.25 times higher odds to pass their course than developmental only students. None of the seven predictor variables were statistically significant. Rural students, first-generation students, Pell

Grant status, age, and sex was nearly even with an odds ratio close to 1.00. Being non-white decreased the odds ($OR = .87$) of completing a college-level math course. Increases in the number of credits slightly decreased the odds ($OR = .92$) of passing a college-level math course.

Table 16

Logistic Regression Predicting Likelihood of College-level Math Course Completion Based on Race, Sex, Urban or rural, Ethnicity, First-generation Status, Number of Credits Taken That Term, or Pell Grant or No Pell Grant

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>df</i>	<i>p</i>	Odds Ratio
Course Type	0.23	.18	1.54	1	.215	1.25
Age	0.12	.01	2.09	1	.148	1.01
Sex(1)	-0.01	.13	0.01	1	.977	0.99
Urban or Rural(1)	0.12	.17	0.47	1	.494	1.13
Ethnicity(1)	-0.14	.14	0.94	1	.332	0.87
First Gen.(1)	0.07	.15	0.23	1	.634	1.07
Credits	-0.03	.02	3.18	1	.074	0.92
Pell Grant(1)	0.23	.14	2.74	1	.098	1.26
Constant	0.79	.34	5.34	1	.021	2.19

$p = .068$

College-level math grades. The following research question guided the analysis of college-level math grades earned by the students in the comparison and experimental groups. For

the two groups in the study, is there a difference in the grades of students in their college-level math courses by the end of the spring 2017 semester? Crosstabulation descriptive statistics were used to analyze the data of college-level math grade performance of the two groups in this study. There were 208 co-enrolled developmental (CD) math students and 991 developmental only (RD) math students who took college-level math courses and earned a grade with the grade distribution listed below in Table 17. A large portion of group one students ($n = 6,417$) did not attempt a college-level math course in the fall 2016 or spring 2017 semesters and did not have a grade to analyze. Developmental only students appeared to achieve at about the same rate as those who co-enrolled.

Table 17

Students' College-level Math Course Grades

Group	A	B	C	D	F	W	Total
DO	148 14.93%	235 23.71%	228 23.01%	102 10.29%	171 17.26%	107 10.80%	991
CD	25 12.02%	46 22.11%	53 25.48%	33 15.87%	40 19.23%	11 5.29%	208

DO = Developmental Only; CD = Co-enrolled Developmental

A cumulative odds ordinal logistic regression with proportional odds was run to determine the effect of students who co-enrolled developmental math or developmental only math, on the belief that co-enrolled students differed in college-level math grades than developmental only students (Table 18). The deviance goodness-of-fit test indicated that the model was not a good fit to the observed data, $\chi^2(2) = 4.532$, $p = .104$, and most cells were sparse with zero frequencies in 78.0% of cells. However, the relationship of the course type on college-level math grades was statistically significant, $\chi^2(2) = 42.304$, $p < .001$. The odds ratio of being in a higher category of the dependent variable, college-level grades, for co-enrolled students versus developmental only students was 5.663, 95% CI [0.822, 2.646], a statistically significant effect, $\chi^2(1) = 13.895$, $p < .001$.

Table 18

Logistic Regression Predicting Likelihood of College-level Math Grades

	95%CI	SE	Wald	df	p	Odds Ratio
Course Type	.822/2.646	.47	13.90	1	<.001	5.66
Constant	-.059/.515	.15	2.42	1	.120	1.26

A second cumulative odds ordinal logistic regression with proportional odds examined the effect of age, sex, urban or rural, ethnicity, first-generation status, number of credits taken that by Spring 2017, or Pell Grant or no Pell Grant, to test whether co-enrolled students differed in college-level math grades as compared with developmental only students (Table 19). This regression analysis was done on a very small sample size ($N = 766$). The deviance goodness-of-fit test indicated that the model was a good fit to the observed data, $\chi^2(16994) = 5119.139$, $p = 1.000$, but most cells were sparse with zero frequencies in 78.0% of cells. The final model statistically significantly predicted the dependent variable over and above the intercept-only model, $\chi^2(10) = 59.408$, $p < .001$. The odds ratio of being in a higher category of the dependent variable, college-level grades, for co-enrolled students versus developmental only students was 5.264, 95% CI [0.773, 2.549], a statistically significant effect, $\chi^2(1) = 13.446$, $p < .001$.

Age was not a significant predictor of college-level grades ($p = .818$) with all other variables being held constant. Likewise, ethnicity, ($p = .933$) and first-generation status ($p = .790$) were not significant predictors of grades while all other variables being held constant. The number of credits for the term was a significant predictor ($p = .022$) of college-level grades. The odds of males getting better grades was 0.908, 95% CI [-0.283, 0.091] times than for females, $\chi^2(1) = 1.004$, $p = .316$. The odds of rural students getting better grades was 0.822, 95% CI [-0.434, 0.042] times than for urban students, $\chi^2(1) = 2.611$, $p = .106$. The odds of non-Pell Grant students getting better grades was 0.813, 95% CI [-0.409, -0.005] times than that of Pell Grant students, a statistically significant effect, $\chi^2(1) = 4.023$, $p = .045$.

Table 19

Logistic Regression Predicting Likelihood of College-level Math Grades Based on Age, Sex, Urban or Rural, Ethnicity, First-generation Status, Number of Credits Taken That Term, or Pell Grant or No Pell Grant

	95%CI	SE	Wald	df	p	Odds Ratio
Course Type	.773/2.549	.45	1.54	1	.001	5.26
Age	-.012/.009	.01	.05	1	.818	.99
Sex(1)	-.283/.091	.10	1.00	1	.316	.91
Urban or Rural(1)	-.434/.042	.12	2.16	1	.106	.82
Ethnicity(1)	-.185/.201	.10	.01	1	.933	1.01
First Gen.(1)	-.230/.175	.10	.07	1	.790	.97
Credits	.004/.052	.01	5.26	1	.022	1.03
Pell Grant(1)	-.409/-.005	.10	4.02	1	.045	.81
Scale	-.082..489	.15	1.95	1	.162	1.23

Completed credits for the spring 2017 term. The fourth research question examined the number of credits completed by students in the comparison and treatment groups by the end of the spring 2017 semester. Crosstabulation descriptive statistics were used to produce the data in Table 20. All students ($n = 2,976$) who took a developmental math course before the fall 2016 semester were removed from the sample. More than a third (35.50%) of group one students earned 29 or fewer credits, 38.86 % earned 30 to 59 credits, 22.65% earned 60 to 89 credits, 2.57% earned 90 to 120 credits, and 0.42% earned more than 121 credits. The findings indicated

that 38.94% of co-enrolled students earned 29 or fewer credits, 38.46% earned 30-59 credits, 20.68% earned 60 to 89 credits, 1.92% earned 90 to 120 credits, and 0.00% earned 121 or more credits.

Table 20

Students' Total Number of Credits by the Spring 2017 Semester

Group	<=29	30-59	60-89	90-120	121+	Total
DO	2630 35.50%	2879 38.86%	1678 22.65%	190 2.57%	31 0.42%	7408
CD	81 38.94%	80 38.46%	43 20.68%	4 1.92%	0 0.00%	208

DO = Developmental Only; CD = Co-enrolled Developmental

Results of a univariate, one-way ANOVA indicated, in Table 21, that there was a statistical difference in the two groups by the dependent variable of number of credits earned, $F(1, 7616) = 5.96, p = .015$. Furthermore, descriptive statistics showed that the developmental only student group ($M = 42.09, SD = 26.11$) and the co-enrolled student group ($M = 37.62, SD = 24.42$) were not similar. Results of the pairwise comparisons showed that developmental only

students took significantly more credits and that the mean difference of 4.475 was significant ($p = .015$) at the .05 level.

Table 21

Students' Number of Credits Taken by the Spring 2017 Semester

Group	<i>M</i>	<i>SD</i>	<i>N</i>
Developmental Only	42.09	26.11	7408
Co-enrolled Developmental	37.62	24.42	208

$p = .015$

A second univariate, one-way ANOVA indicated, with added independent variables that the relationship of spring total credits on the two groups was statistically significant, $F(1, 7602) = 6.444$, $p = .011$ (See Table 22). Age group, urban or rural status, number of credits, and Pell status, were significant predictors of spring total credits. Sex, ethnicity, and first-generation status, were not significant predictors of spring total credits.

Table 22

Students' Number of Credits Taken by the Spring 2017 Semester Based on Age Group, Sex, Urban or Rural, Ethnicity, First-generation Status, Number of Credits Taken That Term, or Pell Grant or No Pell Grant

	<i>df</i>	<i>F</i>	<i>p</i>
Age Group	2, 7602	30.144	<.001
Sex(1)	1, 7602	2.063	.151
Urban or Rural(1)	1,7602	56.314	<.001
Ethnicity(1)	1,7602	1.448	.229
First Gen.(1)	2,7602	.941	.390
Credits	1,7602	95.029	<.001
Pell Grant(1)	1,7602	11.852	.001

p = .011

Results of the pairwise comparisons found that developmental only students took significantly more credits and that the mean difference of 4.60 was significant ($p = .011$) at the .05 level (See Table 23).

Table 23

Students' Number of Credits Taken by the Spring 2017 Semester Based on Age Group, Sex, Urban or Rural, Ethnicity, First-generation Status, Number of Credits Taken That Term, or Pell Grant or No Pell Grant

Group	<i>M</i>	<i>SD</i>	<i>N</i>
Developmental Only	43.61	3.53	7408
Co-enrolled Developmental	39.01	3.95	208

$p = .011$

Developmental math course completion by type of college. The fifth research question analyzed the completion of developmental math by rural or urban college students.

Crosstabulation descriptive statistics produced the data in Table 24 showed that 45.76% of developmental only students that attended a rural college completed developmental math, and 42.72% of developmental only students that attended an urban campus completed developmental math. Similarly, the percentage of co-enrolled students that attended each type of campus and completed a developmental math course in nearly the same.

Table 24

Students' Developmental Math Course Completion by Type of College

Group	Completed	Did Not Complete	Unknown	Total
DO Rural	701 45.76%	824 53.79%	7 0.45%	1532
DO Urban	2510 42.72%	3315 56.42%	51 0.86%	5876
CD Rural	30 75.00%	9 22.50%	1 2.50%	40
CD Urban	124 73.81%	39 23.21%	5 2.98%	168

DO = Developmental Only; CD = Co-enrolled Developmental
 $p = .820$

Results of a univariate, one-way ANOVA indicated that the relationship between the two the independent variables and rural or urban status was not statistically significant, $F(1, 7548) = 0.52, p = .820$. The rural and urban students were similar in the completion of developmental math courses.

Summary

Utilizing descriptive statistics, univariate ANOVAs, binary logistic regressions, and ordinal logistic regression, the data analysis provided the necessary information to produce findings. Co-enrolled developmental students were more than four times likely to complete their developmental course than developmental only students. Co-enrolled students completed college-level math at a rate of 75% and their developmental only peers completed at a rate of 10%. Co-enrolled students were more than five times more likely of earning a higher grade in college-level math than developmental only students. Developmental only students took significantly more credits than co-enrolled students. No matter the type of institution, rural or urban, there was not a statistically significant difference in the two groups completing developmental math coursework.

CHAPTER 5

Discussion and Conclusion

Overview

Across America, nearly two-thirds of community college students were not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015; Jaggars & Hodura, 2013). Students place into developmental math courses that may or may not help them to be successful in math. Based on the findings of this study, co-enrolled developmental and college-level math experiences provided a solution for students to be more successful in college-level math. This study examined completion rates and grades of developmental and college-level math, the number of credits students attained, and the rural-urban breakdown of student developmental math success.

Discussion of the Research Findings

This study was part of an examination of the lack of success students experience in developmental math coursework. Developmental math course completion, college-level math completion and grades, the number of credits completed by the spring 2017 semester, and developmental math course completion by the type of college were examined to see if co-enrollment was a better solution for students to succeed in math than the developmental only math program. The first group (n = 7408) represented the developmental only math students who took developmental math courses and then subsequently took college-level math. The second group (n = 208) represented the co-enrolled developmental math students that took developmental and college-level math in the same semester.

Developmental math course completion. The first research question examined the completion rates of students in the two groups in this study, developmental only, and co-enrolled. Developmental only students completed their developmental math courses at a rate of 43.35%, and co-enrolled developmental students completed their developmental math courses at a rate of 74.04%. Co-enrolled students were four times more likely to complete their developmental courses than developmental only students.

By the addition of the covariates of age, sex, urban or rural, ethnicity, first-generation status, the number of credits taken by the Spring 2017 semester, and Pell Grant or no Pell Grant, the explanation of the model (Nagelkerke R^2) increased by 13%. Of the seven predictor variables, three were statistically significant: age, number of credits, and Pell Grant status. Increasing age was associated with an increased likelihood of passing a developmental course, but increasing the number of credits was associated with a reduction in the likelihood of passing a developmental course. Students that received a Pell Grant are less likely to pass a developmental course. Sex, urban or rural status, ethnicity, and first-generation status were not significant predictors of developmental math course completion.

College-level math course completion. The second research question examined college-level math completion. Developmental only students completed college-level math at a rate of only 9.63%, yet the co-enrolled developmental math students completed college-level math at a rate of 75.48%. The completion rate difference between the two groups was 65.85%. There was a large group of developmental only students ($n = 6,417$) that never attempted a college-level math course in the fall 2016 or spring 2017 semesters. All co-enrolled students were either in the complete or never complete category.

A binomial logistic regression indicated that co-enrolled developmental students had 1.25 times higher odds to complete their college-level math course than developmental only students. When demographic predictor variables were added to a second binomial logistic regression, none of the seven predictor variables were statistically significant.

College-level math grades. The third research question looked at college-level math grade performance. A large portion of group one students ($n = 6,417$) were removed from the grade analysis because they did not enroll (never attempt) in a college-level math course. Developmental only students earned a grade of A, B, C, or D at a rate of 71.94% and the co-enrolled students earned a grade of A, B, C, or D at a rate of 75.48%; a difference of 3.54%.

Developmental only students withdrew at a rate of 10.80%, and the co-enrolled students withdrew at a rate of 5.29%; a difference of 5.51%. There was a significant difference in withdrawal rates of the two groups, and this analysis further suggested that co-enrollment reduced the withdrawal rates of students that took college-level math courses in half. The odds ratio of being in a higher category of the dependent variable, college-level grades, for co-enrolled students versus developmental only students was 5.663. Pell Grant students were more likely to have a lower grade in college-level math as compared to non-Pell Grant students. Age, sex, ethnicity, urban or rural status, and first-generation status were not significant predictors of grades.

Completed credits by the spring 2017 semester. The fourth research question responded to the question about the number of completed credits by the end of the spring 2017 semester. There were 225 developmental math students who earned 90 or more credits by the end of the spring 2017 semester, an astoundingly high number who were apparently “stuck” in

developmental mathematics More students must succeed in developmental education without accumulating so many credits.

Results of univariate, one-way ANOVAs indicated that the developmental only students took significantly more credits and that the mean difference of 4.475 was a significant difference ($p = .015$) at the .05 level. The independent variables of age group, urban or rural status, number of credits, and Pell status were significant predictors of the spring 2017 total credits. Sex, ethnicity, and generation status were not significant predictors of students' number of credits by the spring 2017 semester. The pairwise comparisons, with added independent variables, showed that developmental only students took significantly more credits and that the mean difference of 4.595 was a significant difference ($p = .011$) at the .05 level.

Developmental math course completion by type of college. The fifth research question examined the difference, if any, of the developmental math course completion by type of college. No matter the type of institution, rural or urban, students were performing at similar levels in developmental only math and co-enrolled developmental math. Furthermore, results of a univariate, one-way ANOVA indicated that the relationship between the two groups of the independent variables and type of institution, rural or urban was not statistically significant, $F(1, 7548) = 0.52, p = .820$.

Implications for Community College Leaders

Community college leaders could use the findings from this research to explore offering co-enrolled developmental and college-level math on their campus. The findings from this study should cause leaders to investigate their developmental and college-level math results. The results of this study indicated that co-enrolled students had higher completion rates in their developmental math courses than their peers who took developmental and college-level

separately. The study has contributed to the body of research related to the success of co-enrolled developmental and college-level math. If further research results are consistent with the findings of this study, practitioners should develop strategies to implement some of the key findings in this study.

This study supported the hypothesis that co-enrolled students will have better success in college-level math than their peers who enroll in the more traditional model of a developmental math taken separately. Students that experienced the co-enrolled model were more likely to have better college-level math completion rates which should lead to better college completion rates. Faculty and administrators should use the findings of this study to begin to transform their curriculum to include the strategies of the co-enrolled model. College-level math faculty will experience more student success by moving to the co-enrolled model due to more students that completed developmental math. Developmental math faculty will also experience higher completion rates for their courses. The same success of co-enrollment realized at community colleges may be duplicated at high schools. Co-enrollment could cause leaders of dual enrollment programs to offer some level of developmental education to dual enrolled students who struggled to complete college-level math. Policymakers should consider transforming their statewide developmental math education programs to include the co-enrolled math model at community colleges and in dual enrolled programs.

State leaders who revise and develop educational policy should examine the results of this study and make the necessary changes to their developmental education programs. These same leaders must change policy that coincides with the main finding of this study-.

that many students are referred to sequences of developmental math that do not need them. Community college leaders should reform any developmental only practices to include the co-enrolled model.

Students will benefit greatly from the results of this study. More students will likely succeed in co-enrolled college-level math than the developmental only math programs. Students' persistence should increase for fall to spring rates, fall-to-fall rates, and graduation rates due to increases in developmental and college-level math completion of students that used the co-enrolled model. Student retention will also increase due to better completion rates of developmental and college-level math. For many students, math is a major barrier to college math college completion and persistence. Students will accumulate less debt and graduate sooner. Students' lifetime earnings will be higher due to less college debt and quicker times to entering the workforce.

Comparisons with Other Related Research Findings

The importance of this study is to add to the body of research surrounding co-enrollment of developmental and college-level math. There was scant quantitative research on the success or lack of success of the co-enrolled model. The findings of this study agreed with Bailey and Jaggars (2016) research that supported the co-enrolled model and called it possibly the greatest strategy for developmental education the American higher education system has ever seen. Cohen, Brawer, & Kisker (2013) added that intense math support coupled with college-level math, much like the results of this study, was a much better approach than separating the support from the college-level math. Grillo and Leist (2013) suggested that supplemental instruction (SI) can be used to support cognitive skills; however, the focus was that SI was for the most difficult

courses and the elite students, not for developmental students. This study's findings did not support the findings of Grillo and Leist's (2013) research, I found that SI can be beneficial to students enrolled in the study of basic mathematics. Porter (2010) supported SI and gave many examples of successful undergraduate success, but with more elite students; however, this study supported similar success for students who could not pass a math placement test, but could achieve success in the co-enrolled model. Contrasting the viewpoints of the SI scholars, Rebecca Cox, suggested that developmental math education reform must have a new look from the traditional model (2015). The findings from this study support Cox's (2015) movement from the traditional developmental model to the co-enrolled model. Nikki Edgecombe (2011) proposed that developmental education students need an accelerated model for remedial education that reorganizes instruction and curricula to shorten the completion time of college-level math. The co-enrolled model is just such an accelerated model to completion for students. Martinez and Bain (2014) have suggested that developmental education may cost colleges and society too much to continue their support at the college level. Based on the findings of this research, I disagree with Martinez and Bain and support the co-enrolled model for students as a pathway to success in developmental and college-level math.

This study improved on and mostly supported the work of these scholars due to the large data set and the quasi-experimental research design utilized. Data from nine colleges in a southeastern state were analyzed to produce findings that suggested that the co-enrolled model was more likely to produce success for students to complete developmental and college-level math than the developmental only model. Co-enrolled students were more likely to have a grade in college-level math in a higher-grade category. Developmental only students earned

significantly more credits by the spring 2017 semester. Rural and urban students experienced similar completion rates of developmental math.

Recommendations for Further Research

The sample population of this study was 7,616 students from nine colleges in a U. S. Southeastern State. Conducting similar studies in other states would have added to the generalizability of the findings of the study. A future study could utilize other sample population and examine the college completion rates of similar groupings of students. Another study could focus on why students succeeded in developmental and college-level math and their experiences, using a qualitative research design. Additional qualitative research could focus on the rural and urban breakdown of the colleges to examine any identifiable differences. Lastly, a study could investigate a group of developmental students that enroll in developmental only math but do not enroll in college-level math.

Conclusion

Across America, nearly two-thirds of community college students were not academically prepared for college-level coursework (Bailey, 2009; Bailey & Cho, 2010; Bailey & Jaggars, 2016; Bailey, Jenkins, & Jaggars, 2015; Jaggars & Hodura, 2013). Students placed into developmental math courses that may or may not have helped them to be successful in math. Co-enrolled developmental and college-level math was a solution for students to be more successful in math. Co-enrolled developmental math students had better completion rates than their developmental only math peers by a margin of almost two to one. Co-enrolled students had a 30.69% better chance of getting a satisfactory grade in their developmental math course than their developmental only peers. Co-enrolled math students (75.48%) completed college-level

math at higher rates than their developmental only peers (9.63%). Co-enrolled students withdrew at nearly half the rates their developmental only peers.

It is not acceptable that 225 students in this study had 90 or more credits and were still in developmental education. No matter the type of institution, rural or urban, students were performing at similar levels in developmental only math and co-enrolled developmental math. Co-enrolled developmental and college-level math is a better solution for students who need developmental coursework.

References

- Academic Senate for California Community Colleges. (2014). Multiple measures in assessment: The requirements and challenges of multiple measures in the California community colleges. *The Academic Senate for California Community Colleges*, 1-23. Retrieved from <http://proxy.lib.odu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED546756&site=ehost-live&scope=site>
- Arendale, D. (1998). Increasing efficiency and effectiveness of learning for freshmen students through supplemental instruction. *The National Association for Developmental Education and the National Center for Study of the First Year Experience and Students in Transitions*, 1-17. Retrieved from https://www.uni-bielefeld.de/Universitaet/Einrichtungen/SLK/peer_learning/pal/pdf/increasing_efficiency_and_effectiveness_of_learning.pdf
- Arendale, D. (2002). History of supplemental instruction (SI): Mainstreaming of developmental education. *Histories of Developmental Education*, 15-28. Retrieved from <http://www.cehd.umn.edu/CRDEUL/pdf/monograph/2-a.pdf>
- Arendale, D. R. (1994). Understanding the supplemental instruction model. *New Directions for Teaching and Learning*, 60, 11-21. Retrieved from http://s3.amazonaws.com/academia.edu.documents/3462158/Arendale.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1494906045&Signature=0%2Bz3zD%2FpbQnCqDIXIGMoaCSDUIY%3D&response-content-disposition=inline%3B%20filename%3DUnderstanding_the_supplemental_instructi.pdf

- Arendale, D. R. (2017). Postsecondary peer cooperative learning programs: Annotated bibliography 2017 revised. Retrieved from <https://conservancy.umn.edu/bitstream/handle/11299/190796/Peerbib03-2017%20September%2015.pdf?sequence=1&isAllowed=y>
- Armstrong, W. B. (2000). The association among student success in courses, placement test scores, student background data, and instructor grading practices. *Community College Journal of Research & Practice*, 24(8), 681-695. doi:10.1080/10668920050140837
- Askin, J. A. (2007). Community college mission: Re(s)ources make a difference. *Community College Journal of Research and Practice*, 31(12), 977-997. doi:10.1080/10668920600932868
- Bahr, P. R. (2010). Revisiting the efficacy of postsecondary remediation: The moderating effects of depth/breadth of deficiency. *The Review of Higher Education*, 33(2), 177-205. Retrieved from <http://www.jstor.org/stable/40606851>
- Bahr, P. R. (2012). Deconstructing remediation in community colleges: Exploring associations between course-taking patterns, course outcomes, and attrition from the remedial math and remedial writing sequences. *Research in Higher Education*, 53(6), 661-693. Retrieved from <http://www.jstor.org/stable/23257603>
- Bahr, P. R. (2008). Does mathematics remediation work?: A comparative analysis of academic attainment among community college students. *Research in Higher Education*, 49(5), 420-450. doi:10.1007/s11162-008-9089-4
- Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges*, 2009, (145), 11-30. doi:10.1002/cc.352

- Bailey, T., & Cho, S. W. (2010). Developmental education in community colleges. *Community College Research Center*, 1-8. Retrieved from <https://www2.ed.gov/PDFDocs/college-completion/07-developmental-education-in-community-colleges.pdf>
- Bailey, T., & Jaggars, S. S. (2016). When college students start behind. *The Century Foundation*, 1-15. Retrieved from <https://tcf.org/content/report/college-students-start-behind/>
- Bailey, T. R., Jenkins, D., & Jaggars, S. S. (2015). *Redesigning America's community colleges*. Cambridge, MA: Harvard University Press.
- Bailey, T., Jeong, D. W., & Cho, S. W. (2010). *Student progression through developmental sequences in community colleges*. *CCRC Brief*, (45), 1-6. Retrieved from <https://files.eric.ed.gov/fulltext/ED512395.pdf>
- Bailey, T., Jeong, D. W., & Cho, S.W. (2008). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review*, 29(2), 255-270. Retrieved from https://ccrc.tc.columbia.edu/media/k2/attachments/referral-enrollment-completion-developmental_V2.pdf
- Bailey, T., Jeong, D. W., & Cho, S.W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review*, 29(2), 255-270. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/student-progression-through-developmental-sequences-brief.pdf>
- Bass, L. H., & Ballard, A. S. (2012). Student engagement and course registration methods as possible predictors of freshman retention. *Research in Higher Education Journal*, 18, 1-13. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1064635.pdf>

- Baum, S., Ma, J., & Payea, K. (2010). Education pays, 2010: The benefits of higher education for individuals and society. *Trends in Higher Education Series*, 1-56. Retrieved from <https://trends.collegeboard.org/sites/default/files/education-pays-2010-full-report.pdf>
- Belfield, C., Crosta, P., & Jenkins, D. (2014). Can community colleges afford to improve completion? Measuring the cost and efficiency consequences of reform. *Educational Evaluation and Policy Analysis*, 36(3), 327-345. doi:10.3102/0162373713517293
- Belfield, C., & Crosta, P. M. (2012). Predicting success in college: The importance of placement tests and high school transcripts. *Community College Research Center*, (42), 1-41. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/predicting-success-placement-tests-transcripts.pdf>
- Benken, B. M., Ramirez, J., Li, X., & Wetendorf, S. (2015). Developmental mathematics success: Impact of students' knowledge and attitudes. *Journal of Developmental Education*, 38(2), 14-22. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1083365.pdf>
- Bers, T. H., & Smith, K. E. (1991). Persistence of community college students: The influence of student intent and academic and social integration. *Research in Higher Education*, 32(5), 539-556. Retrieved from <http://www.jstor.org/stable/pdf/40196066.pdf>
- Bettinger, E. P., & Long, B. T. (2005). Remediation at the community college: Student participation and outcomes. *New Directions for Community Colleges*, 129, 17-26. doi:10.1002/cc.182

- Bettinger, E. P., & Long, B. T. (2009). Addressing the needs of underprepared students in higher education: Does college remediation work? *Journal of Human Resources*, 44(3), 736-771. Retrieved from <http://isites.harvard.edu/fs/docs/icb.topic1233354.files/Bettinger%20Long%202009%20Adressing%20the%20Needs%20of%20Under-prepared%20-%20JHR.pdf>
- Blanc, R. A., DeBuhr, L. E., & Martin, D. C. (1983). Breaking the attrition cycle: The effects of supplemental instruction on undergraduate performance and attrition. *The Journal of Higher Education*, 54(1), 80-90. doi:10.1080/00221546.193.11778153
- Bol, L., Campbell, K. D. Y., Perez, T., & Yen, C. J. (2016). The effects of self-regulated learning training on community college students' metacognition and achievement in developmental math courses. *Community College Journal of Research and Practice*, 40(6), 480-495. doi: 10.1080/10668926.2015.1068718
- Campbell, D. T., & Stanley, J. C. (1971). Experimental and quasi-experimental designs for research. In N. Gage (Ed.), *Handbook of Research on Teaching* (pp. 1-83). Chicago: Rand McNally.
- Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *American Association for Higher Education Bulletin*, 3, 1-7. Retrieved from <http://files.eric.ed.gov/fulltext/ED282491.pdf>
- Clark, K. M., & May, I. C. (2015). Upper-division transfer students: Designing a supplemental instruction program for nursing students within a science based curriculum. *Community College Journal of Research and Practice*, 39(6), 499-514. doi:10.1080/10668926.2013.849622

- Clotfelter, C. T., Ladd, H. F., Muschkin, C., & Vigdor, J. L. (2015). Developmental education in North Carolina community colleges. *Educational Evaluation and Policy Analysis, 37*(3), 354-375. doi:10.3102/0162373714547267
- Cohen, A. M., Brawer, F. B., & Kisker, C. B. (2013). *The American community college*. San Francisco, CA: Jossey-Bass.
- Collins, M. L. (2008). It's not about the cut score: Redesigning placement assessment policy to improve student success. *Achieving the Dream: Community Colleges Count, 1-25*. Retrieved from <http://www.jff.org/sites/default/files/publications/cutscoreforWeb.pdf>
- Congos, D. H. (2002). How supplemental instruction stacks up against Chickering's 7 principles for good practice in undergraduate education. *Research and Teaching in Developmental Education, 19*(1), 75-83. Retrieved from <http://www.jstor.org/stable/42802159>
- Congos, D. H., & Schoeps, N. (1998) Inside supplemental instruction sessions: One model of what happens that improves grades and retention. *Research and Teaching in Developmental Education, 15*(1), 47-61. Retrieved from http://www.jstor.org/stable/42802498?seq=1#page_scan_tab_contents
- Connors, R., & Smith, T. (2011). *Change the culture, change the game: The breakthrough strategy for energizing your organization and creating accountability for results*. Chicago: Penguin.
- Cox, R. D. (2015). "You've got to learn the rules": A classroom-level look at low pass rates in developmental math. *Community College Review, 43*(3), 264-286. doi:10.1177/0091552115576566

- Cruce, T. M., Wolniak, G. C., Seifert, T. A., & Pascarella, E. T. (2006). Impacts of good practices on cognitive development, learning orientations, and graduate degree plans during the first year of college. *Journal of College Student Development, 47*(4), 365-383.
doi:10.1353/csd.2006.0042
- Dale, E. (1969). *Audiovisual methods in teaching*. New York: Holt, Rinehart and Winston, Inc.
- Davidson, C. J. (2015). Precollege factors and leading indicators: Increasing transfer and degree completion in a community and technical college system. *Community College Journal of Research and Practice, 39*(11), 1007-1021. doi:10.1080/10668926.2014.919619
- Davidson, C. J., & Petrosko, J. M. (2015). Predictors of persistence for developmental math students in a community and technical college system. *Community College Journal of Research and Practice, 39*(2), 163-178. doi:10.1080/10668926.2013.782831
- Dawson, P., van der Meer, J., Skalicky, J., & Cowley, K. (2014). On the effectiveness of supplemental instruction: A systematic review of supplemental instruction and peer-assisted study sessions literature between 2001 and 2010. *Review of Educational Research, 84*(4), 609-639. doi:10.3102/0034654314540007
- Dias, O., Cunningham, A. W., & Porte, L. (2016). Supplemental instruction for developmental mathematics: Two-year summary. *MathAMATYC Educator, 7*(2), 4-9, 55. Retrieved from http://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1029&context=ho_pubs
- Dickeson, R. C. (2009). *Prioritizing academic programs and services: Reallocating resources to achieve strategic balance, revised and updated*. San Francisco, CA: Josey-Bass.

- Dougherty, K. J., Jones, S. M., Lahr, H. E., Natow, R. S., Pheatt, L. E., & Reddy, V. T. (2014). Implementing performance funding in three leading states: Instruments, outcomes, obstacles, and unintended impacts. *Community College Research Center*, (74), 1-61. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/implementing-performance-funding-three-leading-states.pdf>
- Dougherty, K. J., Jones, S. M., Natow, R. S., Lahr, H. E., Pheatt, L. E., & Reddy, V. T. (2014). Envisioning performance funding impacts: The espoused theories of action for state higher education performance funding in three states. *Community College Research Center*, (63), 1-47. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/envisioning-performance-funding-impacts.pdf>
- Dowd, A. C., & Shieh, L. T. (2014). The implications of state fiscal policies for community colleges. *New Directions for Community Colleges*, (168), 53-63. doi:10.1002/cc.20120
- Drake, R. G. (2011). Why should faculty be involved in supplemental instruction? *College Teaching*, 59(4), 135-141. doi:10.1080/87567555.2011.586656
- Edgecombe, N., (2011). Accelerating the academic achievement of students referred to developmental education. *Research Center Brief*, 55, (1-4). Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/accelerating-achievement-developmental-education-brief.pdf>
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Thousand Oaks, CA: Sage.
- Fields, R., & Parsad, B. (2012). Tests and cut scores used for student placement in postsecondary education: Fall 2012. *National Assessment Governing Board*, 1-72. Retrieved from <https://files.eric.ed.gov/fulltext/ED539918.pdf>

- Flek, R., Welt Cunningham, A., Porte, L., Dias, O., & Baker, W. (2015). Supplemental instruction for developmental mathematics: Early results. *MathAMATYC Educator*, 6(2), 45-51. Retrieved from file:///C:/Users/ptanderson/Downloads/mathAmatycArticleFeb2015_2_15_15.pdf
- Fong, K. E., Melguizo, T., & Prather, G. (2015). Increasing success rates in developmental math: The complementary role of individual and institutional characteristics. *Research in Higher Education*, 56(7), 719-749. doi:10.1007/s11162-015-9368-9
- Fonte, R. (2011). The community college alternative. *Academic Questions*, 24(4), 419-428. doi:10.1007/s12129-011-9255-6
- Goldrick-Rab, S., & Cook, M. A. E. (2011). College students in changing contexts. In P. Altbach, P. Gumport, & R. Berdahl (Eds.), *American higher education in the twenty-first century: Social, political, and economic challenges* (3rd ed.). Baltimore, MD: The Johns Hopkins University Press.
- Green, A. B., & Weir, C. J. (2004). Can placement tests inform instructional decisions? *Language Testing*, 21(4), 467-494. doi:10.1191/0265532204lt293oa
- Grillo, M. C., & Leist, C. W. (2013). Academic support as a predictor of retention to graduation: New insights on the role of tutoring, learning assistance, and supplemental instruction. *Journal of College Student Retention: Research, Theory & Practice*, 15(3), 387-408. Retrieved from <http://journals.sagepub.com/doi/pdf/10.2190/CS.15.3.e>
- Grubb, W. N., & Gabriner, R. (2013). *Basic skills education in community colleges: Inside and outside of classrooms*. London, England: Routledge.

- Haberler, Z., & Levin, J. S. (2014). The four Cs of promising practices in community colleges. *Community College Journal of Research and Practice*, 38(5), 403-416.
doi:10.1080/10668926.2012.748381
- Hagedorn, L. S., Cypers, S., & Lester, J. (2008). Looking in the review mirror: Factors affecting transfer for urban community college students. *Community College Journal of Research and Practice*, 32(9), 643-664. doi:10.1080/10668920802026113
- Hays, D. G., & Singh, A. A. (2012). *Qualitative inquiry in clinical and educational settings*: New York: Guilford Press.
- Heil, S., Reisel, L., & Attewell, P. (2014). College selectivity and degree completion. *American Educational Research Journal*, 51(5), 913-935. doi:10.3102/0002831214544298
- Hern, K., & Snell, M. (2010). Exponential attrition and the promise of acceleration in developmental English and math. *Research and Planning Group of the California Community Colleges*, 1-15. Retrieved from
<http://www.careerladdersproject.org/docs/Exponential%20Attrition.pdf>
- Hern, K., & Snell, M. (2013). Toward a vision of accelerated curriculum & pedagogy: High challenge, high support classrooms for underprepared students. Oakland, CA: LearningWorks.
- Hern, K., & Snell, M. (2014). The California acceleration project: Reforming developmental education to increase student completion of college-level math and English. *New Directions for Community Colleges*, 167, 27-39. doi:10.1002/cc.20108

- Horn, R. A., & Ethington, C. A. (2002). Self-reported beliefs of community college students regarding their growth and development: Ethnic and enrollment status differences. *Community College Journal of Research & Practice*, 26(5), 401-413.
doi:10.1080/02776770290041765
- Hoyt, J. E., & Sorensen, C. T. (2001). High school preparation, placement testing, and college remediation. *Journal of Developmental Education*, 25(2), 26-34. Retrieved from <https://search.proquest.com/openview/222e6caa690702d4eb64aac5d556753c/1?pq-origsite=gscholar&cbl=2030483>
- Hughes, K. L., & Scott-Clayton, J. (2011). Assessing developmental assessment in community colleges. *Community College Review*, 39(4), 327-351. doi:10.1177/0091552111426898
- Hurley, M., Jacobs, G., & Gilbert, M. (2006). The basic SI model. *New directions for teaching and learning*, 2006(106), 11-22. doi:10.1022/tl.229
- Jaggars, S. S., & Hodara, M. (2013). The opposing forces that shape developmental education. *Community College Journal of Research and Practice*, 37(7), 575-579. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/opposing-forces-shape-developmental.pdf>
- Jaggars, S. S., Hodara, M., Cho, S. W., & Xu, D. (2015). Three accelerated developmental education programs: Features, student outcomes, and implications. *Community College Review*, 43(1), 3-26. doi:10.1177/0091552114551752
- Jenkins, D., & Rodriguez, O. (2013). Access and success with less: Improving productivity in broad-access postsecondary institutions. *Future of Children*, 23(1), 187-209. Retrieved from <https://muse.jhu.edu/article/508226/pdf>

- Jenkins, P. D., & Fink, J. (2015). What we know about transfer. *Community College Research Center*, 1-8. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/what-we-know-about-transfer.pdf>
- Jenkins, P. D., & Fink, J. (2016). Tracking transfer: New measures of institutional and state effectiveness in helping community college students attain bachelor's degrees. *Community College Research Center*, 1-51. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/tracking-transfer-institutional-state-effectiveness.pdf>
- Karp, M. M., & Bork, R. H. (2012). "They never told me what to expect, so I didn't know what to do": Defining and clarifying the role of a community college student. *Teachers College Record*, 116(5). Retrieved from http://www.completionbydesign.org/sites/default/files/resources/they_never_told_me_what_to_expect.pdf
- Kenney, P. A., & Kallison, J. M. (1994). Research studies on the effectiveness of Supplemental Instruction in mathematics. *New Directions for Teaching and Learning*, 60, 75-82. doi:10.1002/tl.37219946010
- Khoule, A., Pacht, M., Schwartz, J. W., & van Slyck, P. (2015). Enhancing faculty pedagogy and student outcomes in developmental math and English through an online community of practice. *Research & Teaching in Developmental Education*, 32(1), 35-45. Retrieved from <https://www.questia.com/library/journal/1P3-3900964781/enhancing-faculty-pedagogy-and-student-outcomes-in>
- Klimczuk, A. (2015). Public policy: Ethics. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* (pp. 580-585). Oxford: Elsevier.

- Kuh, G. D. (2007). What student engagement data tell us about college readiness. *Peer Review*, 9(1), 4. Retrieved from <http://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=fab866ad-0ddb-467a-bac5-ccc00ebbb9d4%40sessionmgr102&vid=1&hid=101>
- Kuh, G., Kinzie, J., Buckley, J., Bridges, B., & Hayek, J. (2006). What matters to student success: A review of the literature. *ASHE Higher Education Report*, 1-151. Retrieved from https://nces.ed.gov/npec/pdf/kuh_Team_Report.pdf
- Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J., & Gonyea, R. M. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *Journal of Higher Education*, 79(5), 540-563. Retrieved from <http://www.yorku.ca/retentn/rdata/Unmaskingtheeffects.pdf>
- Lahr, H. E., Pheatt, L. E., Dougherty, K. J., Jones, S., Natow, R. S., & Reddy, V. T. (2014). Unintended impacts of performance funding on community colleges and universities in three states. *Community College Research Center*, 1-69. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/unintended-impacts-performance-funding.pdf>
- Leedy, P. D., & Ormrod, J. E. (2016). *Practical research: Planning and design*. Boston: Pearson.
- Malm, J., Bryngfors, L., & Mörner, L.-L. (2011). Improving student success in difficult engineering education courses through Supplemental Instruction (SI)—what is the impact of the degree of SI attendance? *Journal of Peer Learning*, 4(1), 16-23. Retrieved from <http://ro.uow.edu.au/ajpl/vol4/iss1/4>

- Manns, D. (2014). Redefining the role, scope, and mission of community colleges in an international context. *Community College Journal of Research and Practice*, 38(8), 705-709. doi:10.1080/10668926.2014.897079
- MarketWatch. (2015). Class of 2015 has the most student debt in U.S. history. Retrieved from <http://www.marketwatch.com/story/class-of-2015-has-the-most-student-debt-in-us-history-2015-05-08>
- Martinez, M. E., & Bain, S. F. (2014). The costs of remedial and developmental education in postsecondary education. *Research in Higher Education Journal*, 22, 1-12. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1064045.pdf>
- Meling, V. B., Mundy, M.-A., Kupczynski, L., & Green, M. E. (2013). Supplemental instruction and academic success and retention in science courses at a Hispanic-serving institution. *World Journal of Education*, 3(3), 11. doi:10.5430/wje.v3n3p11
- Mireles, S. V., Acee, T. W., & Gerber, L. N. (2014). FOCUS: Sustainable mathematics successes. *Journal of Developmental Education*, 38(1), 26-30. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1071436.pdf>
- Ngo, F., & Kwon, W. W. (2015). Using multiple measures to make math placement decisions: Implications for access and success in community colleges. *Research in Higher Education*, 56(5), 442-470. doi:10.1007/s11162-014-9352-9
- Noel-Levitz. (2011). *National adult learners satisfaction-priorities report*. Retrieved from https://www.ruffalonl.com/upload/Papers_and_Research/2011/ALI_report%202011.pdf
- Nomi, T., & Allensworth, E. (2009). "Double-dose" algebra as an alternative strategy to remediation: Effects on students' academic outcomes. *Journal of Research on Educational Effectiveness*, 2(2), 111-148. doi:10.1080/19345740802676739

- Northouse, P. G. (2016). *Leadership: Theory and practice*. Thousand Oaks, CA: SAGE Publications.
- Peterfreund, A. R., Rath, K. A., Xenos, S. P., & Bayliss, F. (2008). The impact of supplemental instruction on students in STEM courses: Results from San Francisco State University. *Journal of College Student Retention: Research, Theory & Practice*, 9(4), 487-503. Retrieved from <http://journals.sagepub.com/doi/pdf/10.2190/CS.9.4.e>
- Phelps, J. M., & Evans, R. (2006). Supplemental instruction in developmental mathematics. *Community College Enterprise*, 12(1), 21-37. Retrieved from <https://search.proquest.com/openview/f4b2139c908df96dda442bff040ad23c/1?pq-origsite=gscholar&cbl=26254>
- Porter, R. C. (2010). The effects of supplemental instruction on student achievement in college algebra. *Georgia Journal of Science*, 68(3), 124-131. Retrieved from <https://search.proquest.com/openview/c2722eba21d7537ed634f82ba964931f/1?pq-origsite=gscholar&cbl=47203>
- Rabito, E. R., Hoffman, J. L., & Person, D. R. (2015). Supplemental instruction: The effect of demographic and academic preparation variables on community college student academic achievement in STEM-related fields. *Journal of Hispanic Higher Education*, 14(3), 240-255. doi:10.1177/1538192714568808
- Rath, K. A., Peterfreund, A. R., Xenos, S. P., Bayliss, F., & Carnal, N. (2007). Supplemental instruction in introductory biology I: enhancing the performance and retention of underrepresented minority students. *CBE-Life Sciences Education*, 6(3), 203-216. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1964528/>

- Rodríguez, O. (2014). Increasing access to college-level math: Early outcomes using the Virginia Placement Test. *Community College Research Center Research Brief*, 58, 1-7. Retrieved from <http://ccrc.tc.columbia.edu/media/k2/attachments/increasing-access-to-college-level-math.pdf>
- Scott-Clayton, J., Crosta, P. M., & Belfield, C. R. (2014). Improving the targeting of treatment: Evidence from college remediation. *Educational Evaluation and Policy Analysis*, 36(3), 371-393. doi:10.3102/0162373713517935
- Scott-Clayton, J., & Rodríguez, O. (2012). Development, discouragement, or diversion? New evidence on the effects of college remediation. *National Bureau of Economic Research*, 1-47. Retrieved from <http://www.nber.org/papers/w18328>
- Shaya, S. B., Petty, H. R., & Petty, L. I. (1993). A case study of supplemental instruction in biology focused on at-risk students. *BioScience*, 43(10), 709-711. Retrieved from <http://www.jstor.org/stable/1312343>
- Snow, M. A., & Brinton, D. M. (1998) Content-based language instruction: Investigating the effectiveness of the adjunct model. *Teachers of English to Speakers of Other Languages, Inc. (TESOL)*, 22(4), 553-574. Retrieved from http://tesol.aua.am/tqd_2000/TQD_2000/Tq_d2000/Vol_22_4.pdf#page=10
- Snyder, M. (2015). Driving better outcomes: Typology and principles to inform outcomes-based funding models. *HCM Strategies*, 1-36. Retrieved from <http://hcmstrategists.com/drivingoutcomes/wp-content/themes/hcm/pdf/Driving%20Outcomes.pdf>

- Tandberg, D. A., Hillman, N., & Barakat, M. (2014). State higher education performance funding for community colleges: Diverse effects and policy implications. *Teachers College Record, 116*(12). Retrieved from
<file:///C:/Users/ptanderson/Downloads/State%20Higher%20Education%20Performance%20Funding%20for%20Community%20Colleges-%20Diverse%20Effects%20and%20Policy%20Implications.pdf>
- Tandberg, D. A., & Hillman, N. W. (2014). State higher education performance funding: data, outcomes, and policy implications. *Journal of Education Finance, 39*(3), 222-243.
doi:10.1353/jef.2014.0007
- Thomas, P. V., & Higbee, J. L. (1999). Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education, 23*(1), 8-16. Retrieved from
<https://search.proquest.com/openview/2cd6acb1e860476ba24fa30dcc55c897/1?pq-origsite=gscholar&cbl=2030483>
- Tinto, V. (1997). Colleges as communities: Taking research on student persistence seriously. *The Review of Higher Education, 21*(2), 167-177. Retrieved from
<https://muse.jhu.edu/article/30046>
- Vandal, B. (2014). Promoting gateway course success: Scaling corequisite academic support. *Complete College America, 1-12*. Retrieved from
<https://files.eric.ed.gov/fulltext/ED558791.pdf>
- VCCS. (2017). Policy Manual. Retrieved from
<http://www.boarddocs.com/va/vccs/Board.nsf/Public#>
- Walters, G. (2012). It's not so easy: The completion agenda and the states. *Liberal Education, 98*(1), 34-39. Retrieved from <https://eric.ed.gov/?id=EJ976719>

- Wang, F., Betne, P., Dedlovskaya, M., & Zaritsky, J. (2012). Improving undergraduate mathematics learning: Nine research reports by faculty at the City University of New York. *CUNY: Office of Academic Affairs*, 61-67. Retrieved from <https://www.cuny.edu/news/publications/imp.pdf>
- Weinstein, C. E., & van Mater Stone, G. (1993). Broadening our conception of general education: The self - regulated learner. *New Directions for Community Colleges*, 1993(81), 31-39. doi:10.1002/cc.36819938106
- Wild, L., & Ebbers, L. (2002). Rethinking student retention in community colleges. *Community College Journal of Research and Practice*, 26, 503-519. doi:10.1080/02776770290041864
- Wright, G. L., Wright, R. R., & Lamb, C. E. (2002). Developmental mathematics education and supplemental instruction: Pondering the potential. *Journal of Developmental Education*, 26(1), 30-35. Retrieved from https://s3.amazonaws.com/academia.edu.documents/355864/PDF_of_our_JDE_article.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1511537458&Signature=UiAEtA0dWLOICJx462pAdznbQMU%3D&response-content-disposition=inline%3B%20filename%3DDevelopmental_Mathematics_Education_and.pdf

APPENDIX A

IRB Exemption Letter



OFFICE OF THE VICE PRESIDENT FOR RESEARCH
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23508 **Mailing****Address**

Office of

Research

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Phone(757) 683-3460

Fax(757) 683-5902

DATE: July 12, 2017

TO: Dana Burnett

FROM: Old Dominion University Education Human Subjects Review
Committee

PROJECT TITLE: [1092269-1] CO-ENROLLING STUDENTS IN MATH REMEDIATION
AND COLLEGE-LEVEL MATH IN A COMMUNITY COLLEGE
SYSTEM

REFERENCE #:

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS

DECISION DATE: July 12, 2017

REVIEW CATEGORY: Exemption category # 6.4

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Jill Stefaniak at (757) 683-6696 or jstefani@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

VITA

PETER T. ANDERSON

1980 OILWELL ROAD

Blacksburg, VA 24060

Phone: 540-808-7253

ptanderson@nr.edu**OBJECTIVE**

Dedicated, enthusiastic, knowledgeable and hard-working education professional is seeking to further my education in advanced graduate study.

SUMMARY OF QUALIFICATIONS

- Four months of professional postsecondary experience as the Interim Vice President for Instruction and Student Services
- Three years and eleven months of professional postsecondary experience as the Dean of Business and Technologies
- Two years and six months of professional postsecondary experience as an associate professor and administrator with experience in postsecondary teaching in career and technical education.
- Twenty-six years of full-time leadership experience in education, industry and the military.
- Superb management and organizational skills.
- Excellent written and oral communication skills.
- Familiar with college, VCCS and national education standards and policies.
- Proven track record of successfully managing people.
- Experience with the following teams: Advanced Manufacturing Group (AMG), Advanced Learner's Program (ALP) (co-chair), Title IX, Fiddle and Banjo Club
- Exceptional skills in interacting and maintaining positive relationships with multi-faceted individuals within the college and with external agencies.

CAREER EXPERIENCE/JOB HISTORY**July 1, 2017 – present:****Interim Vice President for Instruction and Student Services**

- Leading a group of valuable professionals that lead the college's instruction, student services, distance education, library, and assessment divisions and groups.
- Member of the President's Staff.
- Ensure the curriculum is updated annually to and communicated to the President, College Board, the VCCS, SACSCOC, and SCHEV.
- Ensure the Student Services Unit is functioning as a highly operational part of the college.
- Member of the SACSCOC Team.
- Member of the VCCS ASAC Committee.
- Collaboration with other institutes of higher education.
- Maintain an exceptional relationship and partnership with the local school divisions.
- Member of SCHEV's State Committee on Transfer
- Member of the Virginia Assessment Group that guides assessment policies, procedures, and guidelines in Virginia.
- Foster and maintain outstanding opportunities for Dual Enrollment of high school students.
- Lead the scheduling creation process each semester.
- Emcee the Fiddle and Banjo Club free shows.
- Serve on the Blacksburg Rotary Club.
- Foster and assist the Workforce Development Division in offering a world-class workforce instructional delivery program

August 1, 2013 – June 30, 2017:

Dean of Business and Technologies, New River Community College

- Led a group of exceptional faculty numbering 70-100 per semester.
- Led the recruitment, selection, evaluating, supervising and hiring of competitive faculty.
- Guide the division in curriculum changes that are validated by industry and educational representatives that make up the advisory committees.
- Managed an operational and strategic budget of \$750K-\$2 million annually.
- Integral leader of the college's Advanced Manufacturing Group.
- Member of the New River Valley Career Pathway's Consortium.
- Served on the VCCS Dual Enrollment Plan Workgroup that is charged with developing the plan that will lead the VCCS dual enrollment initiatives.
- Worked closely with the VP of Workforce Development to meet the training needs of business, industry, and labor in our service region.
- Assistant Director of the NRCC Fiddle and Banjo Club. The Club is one of the avenues for the college with regards to community outreach and development.

November 2010 – July 31, 2013:

Associate Professor and Administrator, New River Community College

- Demonstrated knowledge of the philosophy of our college that possesses world-class faculty where student instruction is our number one priority.
- Involved in the recruitment, selection, evaluating, supervising and hiring of competitive faculty in the Division of Business and Technologies.
- Developed programmatic changes in the curriculum of HIM aligning with current business and industry expert guidelines, national credential testing blueprints and local advisory committee members.
- Implemented and secured funding for workforce development training that addressed community healthcare training needs. Lewis-Gale Montgomery Hospital, Lewis Gale Pulaski Hospital, Carilion NRV Medical Center and the Galax Chapter of the American Association of Professional Coders (AAPC) all received customized workforce development training and credentialing.
- Led a faculty team that implemented new health care programs in Medical Coding and Health Information Management and revised programs in the Medical Administrative Support associate degree and Pharmacy Technician Career Studies Certificate.
- Served on various review teams where faculty gave excellent presentation reports on their program review and assessment. At various times assisted faculty with this process.
- Develop effective plans for providing excellent service to students.
- Served on various classified staff interview and selection committees.
- Assisted with the development and planning of HIM distance education courses.
- Assisted the Dean with preparing the academic class schedules each semester to include distance learning courses.
- As the Coordinator of the Advanced Manufacturing Group led the team of faculty and staff that engineered the design of the Fab Lab. Led the team's strategic budget and planning process. Organized various industry tours for the AMG to expand and grow the college's AMG mission that included a 16 member, 3-day tour to the Richmond, Virginia Beach and Williamsburg areas.
- Conducted two-semester "startups" in the absence of the Dean that included faculty productivity management.
- Member of the NRV Career Pathways Consortium. Assisting the region's CTE Directors with strengthening dual enrollment opportunities and fostering new courses as appropriate.

2009 – 2010:

CTE Director, Pulaski County Public Schools

- Implemented wholesale industry credential testing to address emerging needs of business and industry with a first-year success rate of 58 percent.

- Supervised twenty-nine faculty and one administrative assistant that was student-centered and loved what they did.

2004 – 2009:

Assistant Principal, Pulaski County High School

- Supervised thirty-five faculty and five security officers.
- Liaison to the school custodial and maintenance staff.
- Led the English Department's redesign of the curriculum to align with the SOLs twice.

2003 – 2004:

Assistant Principal, Dublin Middle School

- Co-chair of the school-wide leadership team.
- Supervised forty-three faculty including the recruiting, hiring, and evaluating.
- Liaison to the school cafeteria staff that included overall supervision of the staff.

1996 – 2003:

Building Trades Instructor, Pulaski County High School

- Presented an Achievement Award from Professional Builder Magazine for excellence in teaching.
- Supervised students that built houses that were sold to the public.
- Led an advisory committee that was instrumental to the success of the program. Members of the committee were from industry, education, and government.

1998 – 2000:

Adjunct Faculty, New River Community College

- Demonstrated successful teaching of Career and Technical Education courses.
- Received highly successful student evaluations.
- Provided instruction to students preparing them to become licensed electricians.

1991 – 1996:**Master Electrician, Carter Electric Co., Blacksburg, VA**

- Ensured quality electrical installations and service work.
- Four years of full-time leadership supervisory experience leading crews of electricians.
- Estimated materials planned the workflow and managed the workforce while going to school full time.

1988 – 1991:**Paratrooper, 82nd Airborne Division, Ft. Bragg, NC**

- Earned Soldier of the Month for the 82nd Airborne Division twice.
- Served in the first Gulf War in Iraq – Operation Desert Storm.
- One year of full-time leadership experience, 2nd in command of my group.
- Awarded the Army Commendation Medal of Valor in a combat zone.

EDUCATION

2001 – 2003: Master of Science in Educational Leadership, Radford University

1995 – 1996: Bachelor of Science in Vocational Industrial Education, Virginia Tech

1992 – 1995: Associate of Arts and Sciences in Education, New River Community College

HONORS AND ACTIVITIES

2012 New River Community College representative to the VCCS Faculty and Administrators

Leadership Academy

2013, 2012, 2011 Chancellor's Retreat Participant

Lead Building Trades Teacher, Virginia DOE, 1997-2003

Professional Builder Magazine, National Achievement Award, 2000

Blue Ridge World of Work Regional Award for Excellence in the Classroom, 1999

Virginia SkillsUSA-VICA Advisor of the Year 1997-1998

US Army National Defense Service Medal, 1991

US Army Southwest Asia Service Medal, 1991

Kingdom of Saudi Arabia Liberation of Kuwait Medal, 1991

US Army Commendation Medal for Valor of Service in Desert Storm, 1991

REFERENCES

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