Regression Analysis of Remedial Mathematics Students' Success in the Technical College System of Georgia

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ABSTRACT

Colleges and universities across the nation are diligently working to identify academic hindrances that affect student retention and graduation. The purpose of this study was to determine the impact of redesigned remedial coursework on student achievement rate of students enrolled in the gatekeeper mathematics course, between Academic Year (AY) 2012 - AY 2013, to attain an associate degree at the Technical College System of Georgia. The findings of this study indicated that remedial students enrolled in the sequential mathematics course progression were more likely to succeed in the gatekeeper course and achieve the associate degree in fewer semesters, in comparison to students enrolled in the redesigned accelerated mathematics coursework. A logistic regression model comprised of variables such as remedial model enrollment, gatekeeper course success, age, race, gender, and income was formulated to predict specific characteristics of remedial students that were more likely to affect the associate degree attainment. The enrollment in remedial coursework models, race, and income were not significant factors for predicting the likelihood of a student graduating with an associate degree. The probability of remedial students graduating with an associate degree was higher for traditional students and female students. Remedial students passing the gatekeeper course in mathematics was associated with a lower likelihood of achieving an associate degree. The researcher recommends a critical need for refinement of remedial educational structure with targeted curriculum modification holistically integrated with purposeful advisement, sustainable support services, early intervention, and focused guidance from faculty and staff to highly influence remedial students' success at colleges and universities.

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ACKNOWLEDGEMENTS

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DEDICATION

I dedicate my dissertation to my beloved parents, Urmila Vyas and Hasmukh Vyas.

Chapter I

INTRODUCTION

Current State of Education in United States

One of the hallmarks of a developed society is the extent to which its citizens are educated to the point they can be productive members of the society. Findings from a 2015 report by the National Center for Education Statistics (NCES) reported that 81% of all students enrolled in the school year 2011-12 graduated within 4 years after joining high school (NCES, 2015a). Sixty-six percent of the students who graduated high school in 2013 immediately enrolled in a college. Twelve million students were enrolled in a degree granting institution in the year 1990 and this number increased to 17.5 million by Fall 2013. Approximately ten and a half million of these students registered in 4-year colleges, while the remaining 7 million students joined 2-year colleges (NCES, 2015a). The retention rate from 2012 to 2013 for degree-seeking first-time and full-time undergraduate student at 4-year institutions was 80%, while 44% students had a part-time status. However, at 2-year institutions the retention rate for full-time students was 60%, while 43% students attended college on a part-time basis. As reported by NCES (2015b), the total number of degrees granted by all public and private colleges within the United States increased in the range of 36% to 59% between 2002-2003 and 2012-2013, although the graduation rates for colleges and universities did not increase substantially in the last decade.

The data collected on a wide range of categories from educational agencies across the world enable the United States to understand and compare prevalent educational processes in reference to other countries. The Organization for Economic Corporation and Development (OECD), formed of 34 countries, was developed to encourage advancement in the business and fiscal sectors. According to the OECD 2012 report, the United States was tied with Sweden in twelfth place around the world, with respect to 25 to 34-year olds holding a bachelor's or higher degree (NCES, 2015b). Furthermore, the report indicated in 2001, 30% of 25 to 34-year old adults acquired a bachelor's or higher degree in the United States. The attainment rate in the United States for a bachelor's or higher degree among 25 to 34-year olds was 12 percentage points higher than the OECD average in 2001, but it had been reduced to four percentage points in the year 2012 (NCES, 2015b).

The United States Department of Commerce reported that high levels of education resulted in increased earnings in the year 2013 (NCES, 2015a). Students with a bachelor's degree made more than double the salary as those who did not have a high school diploma. These students made 62% more than students who had achieved a high school diploma, and 29% more than students who held an associate degree. The students who held a Master's degree earned 23% more than students who held a bachelor's degree. According to the United States Department of Labor, employment also correlated to educational qualifications and gender (NCES, 2015a). The students who had a bachelor's degree were more likely to get a job than students who had not attained any credential and male students were employed at a higher rate than female students.

Statistics like this show that getting a post-secondary or advanced degree is one of the best options for persons wishing to improve their economic position in society.

Background of Study

The Technical College System of Georgia (TCSG) offers certificates, diplomas, and associate degree programs in a number of occupational fields. The mission of the technical colleges is to educate students and prepare them with skills required to join the workforce. Technical college students may enroll concurrently while attending high school, immediately upon high school graduation, through adult education program completion, through workforce training and development programs, or as a displaced worker. The programs offered in technical colleges are designed to meet the local business needs and the curriculum enables students to learn core competencies along with applicative knowledge for the chosen program of study.

The technical system delivers remedial coursework through categorized Learning Support (LS) courses in the subject areas of reading, English, and mathematics. Upon admittance to a technical college, students take the standardized placement test, Computerized Adaptive Placement Assessment and Support Systems (COMPASS) test for American College Test (ACT). This test has been used since 1983 by higher education institutions to determine subject competency level and place students in appropriate college courses. Dependent on the cut-off scores finalized by TCSG, students may be placed in one or more levels of remedial coursework before being eligible to register for courses explicit to their chosen program of study. The sequential LS course for reading and English consisted of 0096-0098 levels, while mathematics courses were comprised of 0096-0099 levels. Any student needing remediation and pursuing an

associate degree had to complete the highest levels in the discipline before being allowed to enroll in a gatekeeper course, a program required course with noted low success rates and typically a hindrance in academic progression. The student had to successfully complete LS coursework and also had to take the COMPASS test to exit from the LS course, although some colleges administered a departmental exam instead of a COMPASS test to exit the enrolled LS course. A student placed in multiple levels of a subject ended up spending at least 2-4 semesters completing remedial coursework only, which increased the time taken to acquire the credential. The technical system examined the low success rates of remedial students and their impact on the graduation rates across all the technical colleges.

In the year 2011, the Commissioner of TCSG challenged the technical colleges to increase the success rates in LS coursework and indirectly improve the retention and graduation rates (TCSG, 2012). To affect the LS success, the administrators and faculty collaborated to redesign the LS coursework into modular curriculum, which contained all the learning competencies that a student needed to master the remedial coursework. The goal of redesigned courses was to eliminate sequential LS courses, impart specific content for the evident foundational gaps, shorten the time taken to complete developmental coursework, and concurrently prepare students to do well in the enrolled program as defined by successful academic progression. The technical colleges essentially incorporated all the levels within each subject area into a single course and labeled the course as 0090 level. The system office for technical education ensured financial aid would not be affected if a student took 0090 level courses multiple times (TCSG, 2012).

Problem Statement

Low retention and graduation rates of students at universities, colleges, and technical schools have been a major concern in American citizens' ability to compete in the global market place over the last few decades (Kanter, 2011). Performance-based funding, prospective changes in college ratings, and inability to educate society with requisite skills for a specialized workforce have challenged colleges and universities across the nation to increase the number of graduates (Kanter, 2011). Universities, colleges, and technical schools are diligently working to identify academic hindrances to successful degree completion and design approaches that can generate successful student learning outcomes (Kanter, 2011).

The Technical College System of Georgia grants certificates, diplomas, and associate degrees to students in various occupational disciplines. The technical system needs to graduate 80,000 more students by year 2020, as per the Georgia Higher Education Plan (State of Georgia, 2012). The increase in the number of graduates was determined by considering the total number of students who graduated in fiscal year (FY) 2008 as the baseline figure. Current data indicates that the technical system has generated more than 10,000 additional graduates than the goal projected for AY 2009 - AY 2015 (TCSG, 2016). In each semester between AY 2012 and AY 2015, an approximately 13,000 unduplicated students were enrolled in one or more developmental courses at technical colleges. Because of the large number of students requiring remediation and the low graduation rates of these students, one of the major initiatives supporting the degree completion improvement metric involved structured redesign of remedial coursework (TCSG, 2016).

According to TCSG (2012), the student enrollment in remedial mathematics courses was much higher than remedial English courses but the success rates in mathematics were much lower than English courses. The technical colleges' data portrayed that, depending on the number of remedial courses a student was recommended to take, sometimes students spent 1-2 years in remedial education, which prolonged the degree attainment span and potentially impacted the retention and completion rates. In order to reduce the time taken to complete remedial coursework, the technical system redesigned the sequential developmental coursework model to the accelerated developmental coursework model so students can complete selected modules needed for remediation and quickly move through the program coursework (TCSG, 2012).

The technical colleges of Georgia lack important performance data regarding the impact of redesigned coursework on retention and completion, when similar students either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by Technical College System of Georgia. The technical colleges also lack performance data that measures the student learning outcomes in the required gatekeeper mathematics course and the number of semesters taken to attain an associate degree. This lack of data on the impact of the redesigned coursework on retention and completion and the lack of performance data on the gatekeeper mathematics course are two of the issues that are addressed through the completion of this dissertation research.

Purpose

The purpose of this study was to determine if there is a difference in student performance in the gatekeeper mathematics course and the number of semesters taken to

complete the graduation requirements when similar students enrolled in an associate degree program either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by the Technical College System of Georgia. Successful student performance was represented by a course grade of C or better.

Research Questions

In order to determine the impact on student performance in the gatekeeper mathematics course, number of semesters taken to graduate, and specific characteristics pivotal to degree completion, when students took either of the two remedial coursework models, the following research questions were investigated:

RQ1: Is there a significant difference in the pass rate of the gatekeeper mathematics course for students enrolled to earn an associate degree taking the accelerated remedial mathematics course, from similar students taking the sequential mathematics course progression, as determined by the Technical College System of Georgia?

RQ2: Does age, race, gender, income, and the type of remedial enrollment model serve as predictors of degree attainment among students enrolled in the accelerated remedial mathematics course and students taking the gatekeeper mathematics course as determined by the Technical College System of Georgia?

Significance

Over the past few decades colleges, universities, and technical schools all over the country are striving to identify obstacles viewed to prohibit academic achievement and implement strategies to improve student retention and graduation. Colleges across the nation have been challenged to increase the percentage of students successfully

completing their degree programs (Kanter, 2011). The technical colleges were mandated to restructure the remedial coursework to lessen the number of semesters required by the students to learn key foundational concepts (TCSG, 2012). The intent of this study was to investigate if redesigned remedial mathematics courses, to improve student learning and shorten the time taken by technical students to complete mathematics remediation, are effective.

The findings of the study support national, state, and local education policymakers in their efforts to determine the viability of accelerated remedial courses to increase the number of students attaining an associate degree in 2 years. Information will be available to 2-year colleges in the United States allowing them to make informed decisions on remedial courses designed to accelerate student learning. The outcomes of this study provide students with valuable information on whether accelerated coursework can foster mastery of the learning objectives required to succeed in core classes. The results of this study also indicate if secondary curriculum in the K-12 system needs to be modified so that vital concepts are emphasized to facilitate college preparedness.

Conceptual Framework

The conceptual framework of this study is based on Tinto's Interactionalist Theory. This theory influences student learning, academic commitment, and eventual credential attainment (Tinto, 1975), which is why it is appropriate for this study. Tinto's Interactionalist Theory framework relates to student retention at the college, which in turn greatly affects whether the student receives the degree or not (Tinto, 1975). For the purpose of this study, student success is comprised of remedial students passing the

required gatekeeper mathematics course with a course grade of C or better and overall retention, which results in persistence towards degree attainment.

Tinto's Interactionalist Theory

According to Seidman (2005), student retention and factors that affect student persistence have been studied considerably by postsecondary institutions. Empirical studies in the past few decades have been conducted on improving student success in higher education and many different theories were developed based on the noted results. Retention theories related to student success were based on the importance of student engagement as well as the non-institutional factors that affected student progression at college. Student retention theories that have been prevalent are McNeely's College Student Mortality, Astin's Theory of Involvement, Bean's Model of Work Turnover to Student Attrition, Bean and Metzner's Nontraditional Student Attrition, Spady's Model, and Tinto's Model (Seidman, 2005). These theories stress the importance of strong associations between student involvement, student traits, and organizational characteristics, culture, and environment that can affect student's success and student's decision to continue or depart from college (Seidman, 2005).

Educational researchers identified issues that hindered college completion, but Tinto's (1975) model of student integration in college enabled an open discussion at a national level about what can be done in order for students to become an integral part of college and the factors that can effectively aid in degree attainment. Tinto's theoretical model considered inherent characteristics and factors, as illustrated in Table 1, which can cause a student to drop out of a college.

Table 1

Tinto's Dropout Model Characteristics

Categories	Affecting Factors
Family Background	Socio-economic status; Place of residence; Family relationships; Parents' expectations of education
Individual Attributes	Sex; Race; Ethnicity; Motivation; Abilities; Experiences in high school; Achievement levels in standardized tests
Precollege Schooling	High school performance; Grade point average; Institutional attributes; Institutional status; Capability in school
Commitments	Individual capability; Higher education expectations; Commitment levels; Retention; College completion
Academic Integration	Grade achievement; Academic progress; Individual advancement; Organizational and individual relationships; Integration of student commitment and goal accomplishment; Connection between individual development and academic culture
Social Integration	Relationships with peers and college personnel; Connection between student and college culture; College activities; Positive relations resulting into extensive support and sense of belonging
Dropout Decisions	Organizational attributes; Organizational culture; Lack of connection between student and college culture; lack of motivation and academic capability; Socio-economic status; Self withdrawal; Academic removal

(Adapted from Tinto, 1993, p. 114)

Tinto's theory suggested students enrolled in college with certain built-in characteristics and experiences encountered along the way, which at-large formulated the student's commitment to the institution. Furthermore, the educational expectancies towards degree achievement at college were greatly impacted by academic performance and how well the student gets integrated in the college culture. The institutional

commitment and goal accomplishment could fluctuate because of these experiences. The Academic Integration constituted of grades received in enrolled courses and overall scholastic development, which affected student retention in subsequent terms. The social aspect incorporated relationships formed with peers and faculty members. The degree of student integration was mainly responsible for the student's decision to drop out of college. The associations between the student and the higher educational institution were a longitudinal development, which influenced a student's decision to drop out of the college. Tinto noted, students enrolled at college with wide-ranging differences in reference to demographics, educational abilities, and individual motivations. These factors affected students' anticipations of educational attainment at college. The positive or negative experiences a student had with the institution, impacted student's expectations of academic success and commitment and in turn correlated with either college continuation or stoppage (Tinto, 1975).

Tinto (1993) expressed initial student departure theories mainly rested on students' mental approaches to academic determination, which stressed the individual's capabilities and outlook. Other approaches that affected successful student outcomes were academic aptitudes, student temperament and drive, college organization tailored to assist students from high socio-economic areas, monetary hardships, and college makeup and resources availability (Tinto, 1993). Tinto's Interactionalist Theory helped students to integrate within the social and educational communities intentionally put in place by the college to boost student perseverance (Tinto, 1993, pp. 84-137).

Tinto considered 13 main propositions with respect to the interactionalist model that affected student persistence at college. The eighth proposition stated "the greater the

degree of academic integration, the greater the level of subsequent commitment to the institution" (Tinto, 1993, p. 10). Tinto's Interactionalist Theory was empirically backed by other educational researchers as studies confirmed that once a student entered college then the initial and continued support provided by the college affected student persistence at the college and resulted in the student fulfilling the degree achievement goal (Tinto, 2004).

For the purpose of this study, the technical college students' Academic Integration presented by their success in mathematics coursework, consequent retention, and resultant degree attainment were investigated. Conceptual knowledge in the remedial mathematics course facilitated advanced learning in the gatekeeper mathematics course. Student success in remedial coursework can heighten persistence in the gatekeeper mathematics course, which typically is a hindrance to academic progression and retention (Lonergan, Snyder, & Rinker, 2014). The findings of the first research question in this study addressed if the content learned in remedial courses affected academic performance in the gatekeeper mathematics course. The researcher examined if the success gained in both the remedial and core courses enabled the student to continue with the program of study and resulted in student persistence at the college. The research question also considered the number of semesters taken by a student to graduate on time. The researcher investigated if Academic Integration played a prominent role in deciding whether a student was retained at the college and attained the degree or not. The researcher explored distinct student characteristics that enabled academic progression and eventual degree attainment through the second research question.

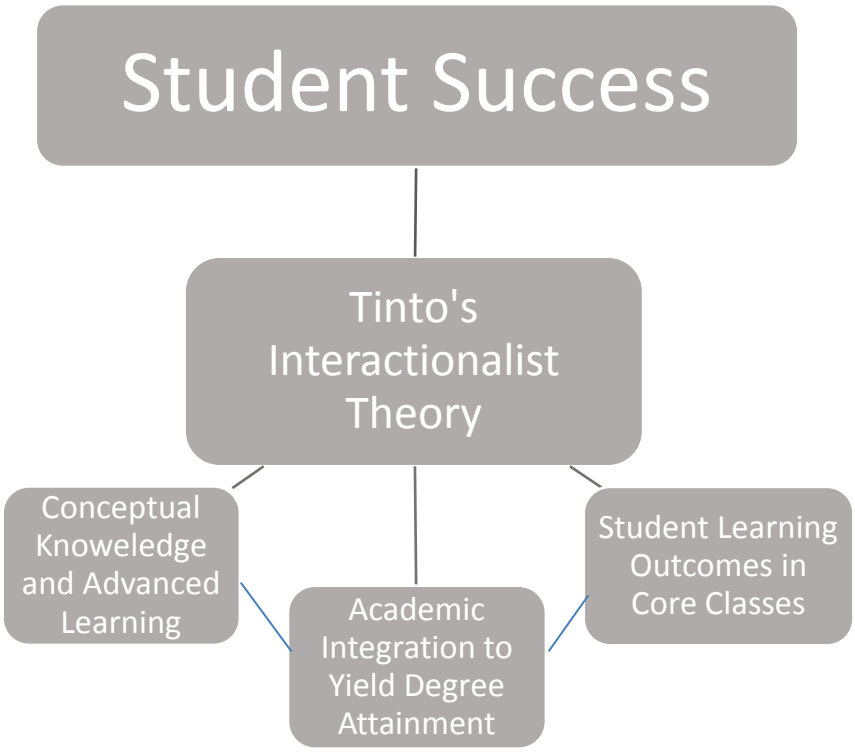

Figure 1. *Association between Student Learning Outcomes and Degree Attainment*

Methodology

The researcher collected data on all students who enrolled in a technical college in the state of Georgia to pursue an associate degree and enrolled in a gatekeeper mathematics course labeled as College Algebra, designated with course number MATH 1111, between AY 2012 and AY 2013. The remedial courses across the technical colleges were delivered through both the sequential and accelerated teaching models in AY 2012 and AY 2013, as colleges were transitioning from traditional coursework to accelerated coursework delivery. The significant number of courses in both remedial models enabled the choice of this time period for the study. The students who enrolled in the MATH 1111 course during the aforementioned time were followed to check if they attained the associate degree or not. The total number of semesters it took for students to

complete the graduation requirements was collected. The data for age, race, gender, and income determined by Pell Grant receipt was also gathered for each of the participants. The demographic information was collected from the centralized database maintained by the Technical College System of Georgia. There were 24 technical colleges within the system in AY 2012 and AY 2013. The Banner Student Information System houses all student records with enrollment status, courses taken, grades, demographic information, financial aid awards, and graduation data for the Technical College System of Georgia.

The participants included in this study were referred to remedial coursework based on the placement scores in the standardized COMPASS test. The cut-off scores were determined prior to the remedial course entry and these scores were dependent on the knowledge of specific skill levels in algebraic concepts. The colleges offering both remedial models did not strategize or limit enrollment in specific accelerated or sequential courses, so students chose between the two models as per their convenience and preferences.

The chi-square test for independence was utilized to investigate student achievement in the gatekeeper mathematics course for both the groups. Student success in terms of retention and associate degree completion, as measured by the total number of semesters taken to graduate, was analyzed through the independent samples *t* test. A logistic regression model predicted the likelihood of requisite student characteristics affecting the associate degree attainment. The student characteristics such as remedial model enrollment, age, race, gender, income, and success in gatekeeper mathematics course were considered in this study.

Limitations

In order to examine the differences in learning outcomes of the gatekeeper course, students' knowledge of foundational algebraic concepts was gained at the same level, irrespective of their enrollment in the sequential or accelerated remedial course model. None of the variables that potentially impacted student performance in mathematics and other occupational courses were controlled in any way and is a limitation of this study. These variables included: location of the technical college; campus of the college; instructor teaching the course; delivery of the course such as traditional, on-line, hybrid, or blended style; day and time of the course offering; and diverse student characteristics. The course grade in the gatekeeper mathematics course may be impacted by one or more of these factors, but for the purpose of this study, these factors have not been considered to be of any significance.

The construction and delivery of the remedial courses is also varied. Some technical colleges offer sequential mathematics courses in lecture form while some colleges offer these courses with content mastery and reinforcement provided by software such as MyMathLab. The accelerated remedial courses do not have any consistency with respect to the course delivery structure across TCSG as some courses offered in class did or did not have a lecture component; some courses offered a co-requisite model with either a college course on Academic Survival Skills or along with the gatekeeper mathematics course; and some courses offered mandatory tutoring sessions while others did not offer these sessions. The sequential courses also have variations across the system such as being offered on various platforms; course delivery solely in lecture form or a lecture delivery supported with technology; or courses offered on different campuses in

dissimilar colleges with diverse student demographics. Some colleges also had additional academic support provided by faculty and peer tutors while other colleges did not have such explicit support. The only required criteria for selection of study participants was that the student be enrolled for an associate degree in a technical college and registered for MATH 1111 between AY 2012 and AY 2013.

Operational Definitions

Acceleration Model. Courses have restructured instruction and curriculum so that developmental coursework can be successfully expedited and completed in this type of framework. Multiple levels of remedial courses are combined into one course.

Contextualized Learning. This instruction involves students learning foundational skills in reading, English, and mathematics concurrent with course content in the program of study.

Co-requisite Model. Mainstreaming or co-requisite enrollment involves students that require remediation to enroll in college-level course with reformed curriculum or additional support provision through tutoring and extra class time.

Enrollment Status. A technical student is considered to be full-time if the student registers for 12 or more credit hours, otherwise the student is categorized as a part-time student.

Fast-track Model. The coursework encompassed in a shortened time frame such as summer semester or mini-mester, where multiple levels of coursework is typically offered in one semester.

Gatekeeper Course. A mandatory course all students need to take for their program of study, typically a hindrance in credential completion due to noted low

achievement rates. The success in this course is dependent on the foundational competencies mastered in developmental coursework.

Modular Coursework. The modular courses categorize learning objectives into specific modules to enhance selective proficiency. This type of coursework allows students to master content on specific concepts that enable success and progress in developmental coursework.

Remedial Education. A student referral to remedial or developmental coursework entails enrollment in selective courses in reading, English, and mathematics to address the academic under preparedness prior to taking college credit coursework. Remedial and developmental have been used interchangeably in this study, but both refer to foundational coursework in the subject area.

Retention Rate. A percentage of students who continue to enroll in the same postsecondary institution in subsequent terms.

Successful Student Performance. Student performance is represented in this study by a course grade of C or better. Successful student performance, student success and pass rate have been used intermittently in this study.

Supplemental Support. Services provided by colleges such as academic tutoring, academic survival skills, and academic and non-academic advising to enhance academic continuation and progression at the college.

Summary

This chapter gave a brief overview of the study and its participants, description of the problem, the significance of the problem and its impact on explicit areas of higher education, the research questions and their role in addressing the problem, the limitations

of study, and definition of the terms relative to this study. The second chapter outlines the available literature as it pertains to the problem.

Chapter II

LITERATURE REVIEW

Remedial education has become an important topic of scrutiny as extensive resources are required at state, institutional, and student levels to address the academic gaps of a vast number of students enrolled in developmental coursework (Venezia & Hughes, 2013). High enrollment and low success rates of students enrolled in remedial coursework is a matter of concern for educators and policymakers. Postsecondary institutions across the country are experimenting with innovative strategies to enhance student achievement and generate progressive academic pathways for these students (Rath, Rock, & Laferriere, 2013). The goal of remedial coursework is to prepare students with foundational knowledge of core competencies vital to academic success, so these students can advance academically and can graduate with a credential on time (TCSG, 2011). On time completion is defined as 2 years for an associate degree and 4 years for a baccalaureate degree (NCES, 2015e). In higher educational institutions of Georgia, approximately 25%-50% of college freshman required remediation; however, 24% of the total students needing remediation attained a bachelor's degree in 6 years while 7% received an associate degree in 3 years (Delaney & Beaudette, 2011). The students enrolled in remedial coursework sequence were more likely to exit college before achieving any credential, therefore it is imperative for colleges to streamline developmental coursework offerings and delivery (CCRC, 2014). A restructured remedial coursework model enables students to take fewer semesters to complete developmental coursework, gain essential skills to succeed in core classes, and complete the program of study in a timely manner (CCRC, 2014).

The technical colleges of Georgia redesigned the developmental coursework, but these colleges lack important performance data regarding the impact of the redesigned coursework on retention and completion, especially when similar students either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by Technical College System of Georgia. The technical colleges also lack performance data that measures successful student learning outcomes in the required gatekeeper mathematics course and the number of semesters taken to attain an associate degree. The purpose of this study was to determine whether students mastered the content in remedial coursework and were able to transfer the foundational knowledge in the gatekeeper mathematics, as depicted by a course grade of C or better. The students participating in this study provided information about the total time taken to complete the graduation requirements and if explicit student traits predicted the overall persistence and degree attainment at the college. The findings of this study also indicated if Academic Integration in Tinto's Interactionalist Theory affected how well the student performs in remedial and gatekeeper mathematics courses and resulted in student persistence at the college to acquire an associate degree.

Any student enrolled in the gatekeeper mathematics course at a technical college in Georgia between AY 2012 and AY 2013 was included in this study. All these students were pursuing an associate degree and would have enrolled in either the sequential or accelerated remedial mathematics model. Each student's end of course grade in the degree level College Algebra course was collected to compare how differently the students in the two groups performed. The number of semesters taken by these students to successfully fulfill the graduation requirements was also examined. Any specific

attributes such as age, race, gender, and income along with remedial enrollment model, gatekeeper success, and time taken for completion, were investigated for both student groups. All these attributes were obtained off the Banner Student Information system.

The literature available for postsecondary education in the United States along with the current problem of a lower percentage of students graduating from college is documented in this chapter. Remedial education, especially in the subject area of mathematics, and the challenges faced by colleges and universities across the country that affect student learning and academic advancement is also discussed.

Postsecondary Education in the United States

Education plays a multi-faceted role in economic, organizational, communal, and religious avenues of any country. A strong foundation provided by the secondary and postsecondary educational institutions results in preparing citizens to design innovative technology to enrich day-to-day lives and compete in global markets. According to Goldin (1999), the educational framework in the United States had been based on European countries, although education in the United States also incorporated extensive applicative concepts, which were not noticeable in European education. Across the United States, education was imparted through private and public funding; however, all the states offered education at elementary levels through public funding after the American Civil War. In the 19th century, education in the United States was dispensed through minimum involvement and revenue provided by the federal and state government. School districts were responsible for all financial and curricular related decisions. Alternatively, many countries in Europe made financial and curricular decisions at national levels, which consequently resulted in lowering educational

attainment at secondary levels in these European countries. The Federal Bureau of Education was founded in the United States in 1867 and was known as the Office of Education in 1929. Initially, the Education Office was encompassed in the Department of Interior and later on became an area of the Federal Security Agency. In 1953, the Education Office was part of the Health, Education, and Welfare agency before becoming the Department of Education in 1980, an independent agency at the cabinet level. In 1837, Massachusetts was the first state to create its Board of Education and thereafter all the states created an office, a bureau, or board of education and also assigned a superintendent or commissioner of education (Goldin, 1999).

Goldin (1999) furthermore stated that data collection for enrollment and literacy rates in the United States was neither constant nor accurate. The educational system in the United States differed from the European educational system as it was not limited to privileged citizens only; however, class and race demarcation was noticeable as only free Blacks were afforded educational opportunity in segregated schools. Initially, more males enrolled in colleges and universities, especially in 4-year programs, but the ratio of female enrollment and graduation rates increased in the 20th century (Goldin, 1999). States had always defined promotion and graduation requirements and a student was automatically admitted to a state university after graduating high school. Typically, higher education programs were for a 4-year span since the mid-19th century, except for some professional degrees such as law and medicine, while junior or community colleges had been comprised of 2-year programs since the mid-20th century. Colleges received funding from the state and federal government, irrespective of public or private status, by sources such as Morrill Land Grant, G. I. Bill, and Pell Grants. Goldin additionally

acknowledged that overall, education reached masses in the United States when (1) schools became free because of public funding; (2) mandatory education laws were passed; (3) need for white-collar and blue-collar jobs increased; (4) "free tuition law" was passed; (5) General Education Development (GED) attainment was feasible; (6) more students graduated from high schools; (7) G. I. Bill was introduced for veterans of World War II and Korea; (8) the Scholastic Aptitude Test (SAT) was incorporated for college admissions in the 1940s; and (9) public junior colleges, also referred to as 2-year or community colleges, widespread in the 1970s enabling students to get higher education even with financial and academic constraints. Despite a high percentage of individuals being able to obtain secondary and postsecondary education in the United States, the drawback of an open and forgiving educational system has translated into flexible curricular standards and lack of national tests. Goldin noted, school districts in lower socio-economic areas were affected because of limited resource allocation, which resulted in less advanced schools, widening the advancement gap between the rich and poor. Association between education and income in the United States makes the equity introspection important in increasing economic growth (Goldin, 1999).

Importance of Higher Education and Role of Community Colleges

In 2011, the Program of International Assessment of Adult Competencies (PIAAC), developed by Organization for Economic Cooperation and Development (OECD), studied, measured, and compared varied skills of adults across the world to get an idea of how well the individuals were prepared to thrive in the current global environment (NCES, 2015f). The researchers surveyed 5,000 adults between the ages of 16 and 65 years in a nationally representative sample across 23 different countries. The

three analyzed areas were: literacy, numeracy, and problem-solving in technology-rich environments. The results of the study were depicted in 0-500 scale scores and 1-5 levels of proficiency. The United States scored below the PIACC International average in all three domains. In the numeracy area, 18 out of the 23 countries had higher average scores than the United States. Approximately 9% of the United States' adults in the 16 to 65-years range scored at the highest proficiency level of 4 or 5 on the PIACC numeracy scale (NCES, 2015f).

According to Yakoboski, d'Ambrosio, and Johnstone (2010), the global economy in the 21st century was rated more by human resources, knowledge, and expertise such as business patents, scientific research and application management, constantly changeable but trained workforce, and occupational education for school and college-levels with a strong focus in science and technology. Postsecondary education was imperative to higher earning and affluence status at individual and national platforms. Community colleges played a significant role in providing reasonably priced education through program offerings tailored towards business needs and developing pertinent workforce (Yakoboski, d'Ambrosio, & Johnstone, 2010, pp. 17-22).

Postsecondary education in the United States offered by colleges and universities differ in characteristics based on degrees conferred, institutional control being private or public, and profit or non-profit operations. Currently, there are more than 4,700 institutions in the country, which grant associates or higher degrees and participate in Title IV federal financial aid programs (Complete College America (CCA), 2012). After high school, a student can enroll in a postsecondary institution that offers programs in academics, vocational training, or professional development. Although, higher

educational institutions in the United States enroll a large number of students, not all students graduate with a credential in a timely manner (CCA, 2012). Examining the 2008 student cohort of first-time and full-time students who were enrolled to obtain a bachelor's degree at 4-year colleges participating in Title IV financial aid programs, 60% graduated from the first institution of attendance in a span of 6 years (NCES, 2015e). The graduation rates of the first- and full-time student cohort of 2011, attaining a certificate or associate degree within 150% of normal time at 2-year colleges participating in Title IV financial aid programs, was 31% (NCES, 2015e).

According to CCA's *Four-Year Myth Report* (2014), postsecondary education in the United States was expensive and took a long time to complete a credential. The graduation rates were also low as around 16% of full-time students graduated on time with a 1-2 year certificate, while 5% of full-time students graduated on time with an associate degree (CCA, 2014). The cost of attendance increased each year approximately by $16,000 for 2-year public colleges and $23,000 for 4-year public colleges. On top of the additional amount paid in tuition and fees, students lost out on wages they would have received had they achieved the credential on time. Moreover, the additional credits taken by the students accounted for more than $19 billion per year to the public institutions. However, none of these figures considered the cost incurred for students enrolled in developmental coursework, students who dropped out of college, or students who did not graduate. The current national data of student loan debt has exceeded a trillion dollars (CCA, 2014).

To decrease student debt and in turn enable accessibility and affordability for postsecondary education, President Obama signed the Student Aid Bill of Rights in year

2015 (Education Advisory Board, 2016). The President proposed free tuition for community college students in the FY 2017 budget. The plan would take care of 75% of tuition for 2 years while 25% of the tuition would be taken care of by the participating states. Community colleges would have to grant credits that could be applicable towards a 4-year degree or grant degrees in high-demand workforce development. All the student at the community college had to do was to maintain a 2.5 GPA, progress academically, and attend at least 50% of the classes. The cost of the plan was estimated to be $61 billion over the next 10 years and the plan would benefit around nine million students (Education Advisory Board, 2016).

According to Dougherty and Townsend (2006), economic factors in the United States generated a wide need for skillful workforce, which in turn stressed the importance of higher education even more. The demand for postsecondary education along with a weakened economy also necessitated many students to enroll in educational institutions. The authors additionally expressed, universities were becoming more selective of the student population that could be admitted as they were charged with enabling the entering cohort to successfully attain credential on time. Colleges also noted changes in state funding and hiked tuition rates to offset the difference, so many high school graduates regarded community college as a better option to gain an associate degree. Community colleges across the nation delivered programs dependent on the missions adopted by the college at-large. Some community colleges focused on workforce advancement and continuous education, while some community colleges focused on developmental education, 2-year degrees, or transition to 4-year colleges (Dougherty & Townsend, 2006).

In many countries across the world, the technical educational system is prevalent within the postsecondary educational arena. Technical colleges provide application oriented training for specialized trades and employment, while incorporating general education within the curriculum. Some students were more likely to drop-out of the educational system but vocational education increased their chances of transitioning in the job market without noticeable wage differences between them and their academically oriented counterparts (Eichhorst, Rodríguez-Planas, Schmidl, & Zimmermann, 2015). Eichhorst et al. (2015) indicated that many students preferred technical education as it provided an opportunity to acquire specialized education at a lower cost and gain the expertise to join the workforce at a quicker rate. Some countries provided technical expertise through supplemental employment training at the workplace. Technical training aided in gaining employment and also improved the pay-scale and long-term employment consequences for low-skilled workers (Eichhorst et al., 2015). Moreover, technical education was beneficial to both the employer and employee in providing gainful employment to steady and well-paid jobs at individuals' career onset. However, technical jobs could not replace general academic requirements for upscale technological and administrative positions in business sectors.

History of Technical Education in Georgia

In 1917, the federal government allotted money for technical training in agriculture in the state of Georgia and a state board was established under the Smith-Hughes Act (Koon, 2013). In 1944, the first technical school in the state called the North Georgia Trade and Vocational School was established in Clarksville and it was shortly followed by the South Georgia Trade and Vocational School in Americus. Regulations

for vocational-technical schools were settled in 1958 and a collaborative system for technical training emerged. This system resulted in the establishment of nineteen technical schools in the state of Georgia by the 1960s. The establishment of the State Board of the Postsecondary Vocational Education by the Governor of Georgia resulted in formation of the Department of Technical and Adult Education (DTAE) in 1988. Twenty technical colleges converted from regional to state-run control in 1986 and the system was labeled as the Technical College System of Georgia (TCSG) in the year 2008. There were 34 technical colleges, although in the recent past many colleges merged to arrive at the current count of 22 technical colleges in Georgia. Quick Start joined the technical system to enable business expansion in Georgia by designing customized but cost free training for selective companies. The Office of Adult Literacy in the Department of Education joined DTAE in 1988 and is responsible for overseeing and awarding GEDs as well as facilitating literacy programs in Georgia. The Office of Adult Literacy, later known as the Office of Adult Education, ensured all adults in Georgia got a chance to master the foundational skills in reading, writing, and communication to get employed or progress in their current job (Koon, 2013).

The mission of the technical system was to develop workforce by integrating educational and applicative training and in turn enhance the state's economic growth (Koon, 2013). The Commissioner and the State Board, comprised of members from each of congressional district and from the state at large, assured the operational policies of TCSG. Each college was assigned a service area of delivery containing various counties within it, where training was to be provided as per the business requirements. Any student 16 years or older, possessing a high school transcript or General Education

Diploma (GED) and High School Dual Enroll could be admitted to a technical college. Technical colleges offered programs of studies that enabled the student to earn a technical certificate, diploma, or Associate Degree. Programs offered by the technical colleges enabled the student to be well-prepared for specialized jobs within the local industries. The technical colleges collaborated with K-12 systems, University Systems, and business communities to provide a seamless transition from education to the workforce with explicit training for economic development (Koon, 2013).

Student Success

Certain students enter 2-year colleges because of personal interest or due to lack of additional options (Goldrick-Rab, 2010). According to Goldrick-Rab (2010), the students' inability to attain credential impacted their personal and professional lives profoundly so improvement in student success is of utmost importance to community colleges. Many students did not succeed with advancement in their program of study which instigated a need to remove the obstacles and create reformative changes that enable students to succeed. Increasing academic success was possible by considering educational policies that collectively worked well and assisted in student achievement at-large. Goldrick-Rab (2010) critically examined studies in education and related policies to identify factors that affected student success in community colleges. The overall organizational framework was considered and its processes with respect to the students' social, economic, and educational traits in order to explain the avenues that can hinder student success. The mentioned areas in the study that could be revolutionized to garner community college success pertained to financial aid, performance funding,

transferability, streamlined employment pathways, applicative learning, courses that teach life skills, high school enrollment, and early assessment (Goldrick-Rab, 2010).

According to Kuh, Kinzie, Buckley, Bridges, and Hayek (2007), student achievement was collectively formed by educational reforms, state policies, and organizational environment. Educational institutions at all levels, family, and community worked collectively to enhance student success and generate exceptional student learning outcomes. An achievement pathway was already paved in secondary education and if a student did not master mathematical and reading skills in middle school then postsecondary successes could be affected (Kuh et al., 2007). The researchers indicated for increasing student achievement in higher education (1) collaboration was required between secondary and postsecondary institutions; (2) alignment was necessary between state standardized tests, college placement requirements, and student success in college; (3) states needed to incentivize schools for preparing students to enroll and do well in college; (4) educators in secondary schools had to be encouraged to have high educational expectations from their students and help them reach those standards by strategically planned educational initiatives; (5) families needed to be educated about all expenses pertaining to college education; (6) colleges were required to make college education affordable by offering monetary assistance such as on-campus jobs, especially to students in the low income bracket; (7) colleges needed to clearly define attributes necessary for student success and inform their students if their performance was adequate or not; and (8) colleges needed to orient students when they enter college, counsel appropriately, create communal environment, intervene as warranted by an early alert

process, provide additional academic support, and enable peer-to-peer interaction and mentoring (Kuh et al., 2007).

Kuh et al. (2007) further specified early alert systems could be advantageous in identifying students encountering academic difficulties so they can be provided with requisite support. The results recommended (1) colleges needed to make extra efforts that involved non-traditional students through learning communities, teaching styles accommodating various learning styles, on-campus activities, and collaborative learning; (2) peer support affected student learning so colleges needed to create avenues to generate extensive student partnerships, frame a culture tailored towards student success, and do everything possible to enhance student achievement; (3) technology was to be used for reinforcement and ample supports needed to be provided for students to successfully navigate institutional resources and in turn, increase academic success; and (4) targeted advisement and counseling also served in molding the instructional delivery to reach students with varied learning styles (Kuh et al., 2007).

According to Tinto (2012), student success could be boosted by educational policies, but educators at the college level need to have highly focused approaches that improved student experiences at the college. Faculty played a prominent role in the education system, so faculty had to be vigilant about continuously identifying and modifying teaching strategies that eliminate barriers to academic achievement. Tinto (2012) illustrated student success could be enhanced by creating effectual classrooms incorporating high levels of academic expectancies by instructors; support services enabling these expectancies to fruitful achievement; periodic assessments and timely feedback of student performance; and social and academic involvement in the classroom

through instructional activities encompassing group work and collaborative learning. Student associations formed through learning communities to impart some important college survival skills help institutions to provide additional support to the student (Tinto, 2012). Tinto found early alert system inclusion also aided in a student receiving timely intervention in case of need. Instructors played a vital role in efficiently employing pedagogical activities, but these instructors needed to be coached to foster student achievement through such activities.

Kuh (2009) suggested there was an increase in favorable outcomes for the institutions involving students in substantial activities, particularly engaging the students from lower socio-economic areas. Student involvement in activities heightened the credential accomplishment and students gained the expertise relevant to contemporary times while acquiring an undergraduate degree. For the past few decades, student affairs staff was very open to new strategies relevant to student success and embraced evaluative and progressive pathways with respect to student engagement (Kuh, 2009).

Astin's (1984) student development theory, concentrated on student involvement at the college, took into account how much time and effort students put in college with respect to studies, other collegial activities, and building relationships with the college personnel. Astin suggested higher student involvement positively affected student learning so college framework had be geared towards student involvement. Henning (2012) identified different studies that stressed the value of student involvement only to student learning and contended student involvement also positively affected college accomplishment. Highly influential strategies instrumental in increasing student

involvement were a result of a commitment and integration of college success with the faculty, staff and administrators' accountability for that shared success (Henning, 2012).

Many students entering higher education may be the first ones in their family to pursue a postsecondary credential (Petty, 2014). These first-generation students may not have personal experiences, environmental support, realistic expectations, or knowledge of skills required to succeed in college. These students may not have the family and communal structure to support their goal of degree attainment. Colleges needed to make these students aware of the connection between academic attainment and social-economic benefits that continuously motivated them to persist and graduate college (Petty, 2014). Petty (2014) stated first-generation students face numerous challenges with respect to academic progression. Colleges played a significant role in acknowledging the internal and external factors that hinder degree completion and needed to implement several different programs that encourage students to stay in college.

Engle and Tinto (2008) noted first-generation students from low-income brackets attended 2-year colleges that were for-profit and left the institution without attaining credential. These students were to be encouraged to attend 4-year colleges and universities by ensuring they were well prepared for college through advanced high school coursework; substantial financial aid that enabled them to stay in college till they completed the program of study; easily transferable courses when they shifted to a 4-year college; adequate support that motivated them to advance academically; opportunities that engaged them in the college culture; and varied entry points for college enrollment for traditional age students (Engle & Tinto, 2008).

Miller (2003) pointed out the student population of postsecondary education was different than what it used to be years ago. As per the NCES description of non-traditional students, these students were not as young, were self-reliant, may have kids, worked full-time, may be single, or may not have completed high school. On top of these characteristics, they may be first-generation students or had wider academic and technological disparities. Since a large mass of students had one or more of these attributes, it was imperative colleges provide support services to these students and educate them. Colleges needed to understand the offerings that worked for traditional students may have to be modified to encompass the new populations' needs. The students residing on campus may be able to take classes at any time of the day but it may be difficult for the non-traditional students to adhere to that schedule because of their family obligations and work related restrictions. Also, colleges needed to train their faculty and staff to address concerns influenced by diverse enrollment. The non-traditional students could have a gap between high school completion and college initiation, which can be filled by remediation education, so care had to be taken in scheduling the remedial courses and providing appropriate academic services (Miller, 2003).

The conceptual framework related to student success was based on various studies that gave importance to student engagement as well as the non-institutional factors that affected fruitful progression (Zepke, Leach, & Butler, 2011). Zepke, Leach and Butler (2011) explored a variety of institutional and non-institutional variables were responsible for forming the student success equation. It was very important to gauge the internal and external factors that contributed or hindered student success. The students juggled with many occasional non-institutional issues while pursuing a credential. The author

suggested institutions to assimilate students into college environment while also keeping in mind student achievement could be impacted by sickness, family, job, fiscal concerns, or by secular bindings (Zepke, Leach, & Butler, 2011).

In the past few decades, a wide variety of studies were examined on student retention and achievement. The theoretical knowledge of various educational and societal factors or the reasons why students left did not give colleges an across-the-board formula to develop and implement, which heightened student success. Also, different researchers perceived student success differently and it was not easy to carry out similar studies with some modifications and enhancements for student success. Examining too many studies with a large number of variations and deciding specific variations responsible for generating the desired outcomes was not a simple task to accomplish (Tinto, 2010).

Overall, colleges offer programs resulting in advanced degree attainment and gainful employment opportunities. State policies were tailored to eliminate hindrances affecting student retention and completion as the completion rates of students in community colleges affect not only the students, but also affect postsecondary institutions, state, and country's economic progression (Rath, Rock, & Laferriere, 2013). Higher enrollment in developmental coursework with lower success rates pinpoint a weakened education system, flawed remedial framework, and insufficient support services. In order for students to enroll and advance academically, it is important to extend proper support, enable simultaneous school and college enrollment, and provide financial rewards (Rath, Rock, & Laferriere, 2013).

Remedial Education in the United States

Educated citizenry trained with explicit skills to meet the competitive global market is deemed to be an important asset of any country's economic growth. President Obama has challenged colleges and universities with an ambitious goal, that in the year 2020 the United States will have the highest number of college graduates in the world. Educators and policy makers in postsecondary institutions across the nation are striving to design operational methodologies to improve student access and success and in turn enable more students to graduate on time (Kanter, 2011).

The National Conference of State Legislatures (2015) reported that 32 states in the nation have performance-based funding for higher education where appropriation is centered on retention and graduation, rather than enrollment. The state of Georgia is currently modifying the funding allocation for postsecondary education to incorporate degree attainment, academic progression, remedial success, and achievement of special populations within the funding formula. Georgia's Higher Education Funding Commission created a postsecondary completion plan for CCA (2012) and projected that by year 2020, 60% of employment opportunities in Georgia will mandate some higher education credential. Currently, 42% of citizens have attained a certificate, an associate degree, a bachelor's degree, or other higher degree. In other words, approximately 250,000 more students will have to graduate to reach the 60% goal.

In the year 2011, CCA awarded $1 million to the state of Georgia to design innovative reforms to boost college completion. A part of this grant was given to four higher education institutions in Georgia to refine and restructure developmental education. The colleges had to incorporate computer-based assessment identifying

students' remediation needs, deliver individualized remedial coursework, simultaneously enroll students in credit-level courses, and overall enhance avenues of student achievement. All the public postsecondary institutions in the state joined the CCA initiative with a goal to produce more graduates. One of the main metrics of this initiative was to increase the success rates of students needing remediation at the college-level as the graduation rates of these students is noted to be low. The Fall 2006 cohort of students enrolled at a 2-year college in Georgia and who were referred to remedial education graduated at 7% (CCA, 2011).

As per the CCA *Remediation Report* (2012), approximately a cost of $3 billion was incurred on developmental coursework across the United States, but only nominal success rates were noticeable. Based on data provided by 33 states, which were a part of the CCA network, around 20% students enrolled in 4-year institutions and 52% students enrolled in 2-year institutions had registered for developmental coursework. Approximately 40% of students enrolled in developmental courses never finished these courses. In 2-year colleges, 22% of the total students successfully completed remedial and associated college-level courses, while around 37% of students completed these courses in 4-year colleges. Students who took remedial courses graduated at a rate of 10% in 2-year colleges within 150% of normal time, while 35% of students graduated within 6 years from 4-year colleges. Developmental programs were intended to be a connection between high school under-preparedness and college readiness, although the retention and graduation rates of remedial students in colleges across the nation did not depict the success of remedial programs (CCA, 2012).

In the state of Georgia, around 18% of students joining 4-year institutions and 37% of students starting 2-year institutions registered in developmental courses. In 2-year colleges of Georgia, 17% of the total students successfully completed the remedial and associated college-level courses while around 35% completed these courses in 4-year colleges. In Georgia, students who took remedial courses graduated at a rate of 7% in 2-year colleges within 150% of normal time, conversely 25% graduated within 6 years from 4-year colleges (CCA, 2012).

Considering the large numbers of students enrolled in remedial coursework and lack of substantive success for these students, led many postsecondary institutions to rethink and redesign the developmental coursework offering and delivery. Recently, many states and colleges received monetary help from government and non-governmental agencies to reform strategies in remedial education. Even though, delivery of developmental coursework and its effectiveness has been a debatable issue for the past few decades, success of developmental coursework was important to both students and postsecondary institutions. Proponents of remedial coursework stressed the importance of teaching foundational skills to students with evident academic gaps, so they can graduate college (Long & Boatman, 2013). Critics on the other hand, disputed that student enrollment in remedial coursework affected student retention and completion at the college. Long and Boatman (2013) noted the research findings of causal effects of remediation were inconsistent and there was not an understanding about how these results differed by state, age, ethnicity, gender, or levels of remediation needs. Also, different student needs for remediation called for wide-ranging interventions that effectively affected the achievement in developmental courses. A standardized and accurate

placement test would enable appropriate identification and enrollment of remediation requirements. The researchers recommended these remedial needs were dependent on skills necessary for success in future coursework instead of what the student did not learn in the past (Long & Boatman, 2013, pp. 77-95).

Educational policymakers looked at high enrollment rates in remedial education as signs of failure as students are apparently not well-prepared for college, especially as high costs and low success rates are associated with these students. Remedial education led to a stronger pathway towards credential attainment and needed effective policies in this area. According to Vandal (2010), many states were putting forth stricter high school graduation requirements and ensuring that remedial needs were addressed by community colleges rather than 4-year universities. Currently, governmental and non-governmental organizations, such as Achieving the Dream (ATD), the Bill and Melinda Gates Foundation, and the Carnegie Foundation, are initiating massive reforms in this area, thus signifying the importance of remedial success in higher education. Even though improved achievement in remedial coursework was regarded to directly affect college completion rates (Vandal, 2010), little is known of the launched initiatives for developmental education or the regulations put in place for the associated remedial policies. The Education Commission of States (ECS) was forming a database that would enable policymakers to compare various data elements of the policies across the nation. This database would contain information on placement tests, determination of foundational skills achievement, standardization of rules for delivery, related funding for interventions, performance measurements, and regulations for data collection and reporting.

Many community colleges in the United States are researching and piloting innovative educational approaches and policies at state level to either eliminate developmental education or improve success rates in remedial education and thus enhance student's academic progress (Jobs for Future, 2010). The ATD organization reported 15 states in the country joined the organization between 2004 and 2007 with explicit aims and objectives to heighten student success as measured by credential acquirement. These states informed their stakeholders about student success and made decisions based on the recorded data. Some states even coordinated data sharing between the K-12 system and higher education. The Virginia Community College System focused on either increasing the graduation rates, boosting transfer rates to 4-year universities, or completing a credential in workforce development by 50% (Jobs for Future, 2010). According to Jobs for Future (2010), another major focus was to improve the success rates for underserved populations by 75%.

Each campus in the University of Hawaii Community Colleges developed a strategic plan that incorporated outcome attainment for remedial coursework completion and credential achievement or transfer to a 4-year institution (Job for Future, 2010). The Cross-State Data Work Group; initially comprised of Connecticut, Florida, North Carolina, Ohio, Texas, and Virginia; collectively formed an assessment that measured performance of community colleges. A recommendation was made for Integrated Postsecondary Education Data System (IPEDS) Graduation Survey to add part-time students, track all the students for 6 years, and consider students transferring to 4-year colleges as successful outcomes. The assessments aided states and colleges to track student advancement and completion. The Department of Higher Education in

Massachusetts developed a transfer agreement that guaranteed a transfer of credits and financial aid to a 4-year college, if the student had the required GPA (Jobs for Future, 2010).

The state of Florida passed the Florida Legislature Senate Bill 1720 for systemic restructuring of remedial education. The Florida College System (FCS) was required to reform teaching strategies, incorporate intrusive advising, and provide additional supportive avenues to students (Hu, Tandberg, Park, Nix, Collins, & Hankerson, 2014). The students who started nineth grade in 2003 or later, students who achieved high school diploma in Florida, or students who were active in the United States Armed Services were not referred to remedial courses. All 28 colleges delivered instruction through modularization and compression models. Seventeen of 28 colleges also incorporated a co-requisite model. The goal of the modularized courses was to take care of specific skills deficiency, enable students to advance from remedial to college-level courses, obtain instruction for coursework related to the chosen major of study, and concurrent enrollment in college-level coursework with additional support provision. Early intervention was also administered for students needing help with academics, finances, childcare, transportation, and other needs. The students were also offered tutoring sessions, workshops, and courses focused on student success (Hu et al., 2014).

In 1995 through 1997, Hoyt and Sorenson (2001) studied the academic readiness of approximately 4,000 seniors in two school districts of Utah. These students either were unsuccessful in high school courses so took foundational courses in English and mathematics, or were successful in advanced placement courses in English and calculus. The students had been placed in English and mathematics remedial courses based on their

ACT or COMPASS tests. A logistic regression model indicated courses taken in high school and the grades achieved in these courses were predictive of placement in remedial coursework (Hoyt & Sorenson, 2001). Students who did not complete higher level mathematics courses in high school or did not achieve high grades were more likely to be referred to remedial education. Ethnicity, number of years between high school graduation, and college enrollment were not significant factors in predicting remedial coursework referral (Hoyt & Sorenson, 2001).

A student may or may not be well-prepared for college upon high school graduation, so colleges need to create avenues addressing any lack of foundational knowledge in areas that may be viewed as problematic for successful degree completion. Dependent on the evident academic deficits, the length of redesigned courses and reinforcement by co-requisite support helps students to fill the knowledge gap (CCA, 2012). CCA (2012) noted that students are more likely to graduate if they successfully passed three or more gatekeeper courses in the first year of college enrollment. Colleges needed to help students identify a program of study and aid them in registering for classes pertinent to the chosen program. Students were to be assisted with academic support to do well in introductory gatekeeper classes so students can progress continuously in their program of study (CCA, 2012).

Postsecondary institutions enroll students from all walks of life so the foundational level content mastery is varied for these students (Hughes & Scott-Clayton, 2011). Institutions' open access capability made it challenging to measure the skills required for a student to do well in the college. The vision of remedial education was to prepare students with a strong foundation that filled the academic gaps to enable success

in college courses and achieve the preferred credential in the desired field of study. Colleges considered appropriate scores of ACT, SAT, or high school exams for college course enrollment; however, enrollment in remedial program was generally determined by a placement test whose cut-off scores were defined by the college. Student competency in reading, English, and mathematics was determined by the college administered placement test when a student was admitted to a postsecondary institution. Some colleges did not allow students to enroll in any credit-bearing college courses until all remedial coursework was successfully concluded, even though such restriction inadvertently formed a hindrance in academic progression at the college (Hughes & Scott-Clayton, 2011).

Additionally, Hughes and Scott-Clayton (2011) indicated various states and various organizations assess their students differently but state stakeholders agree that students needed to be assessed by district or state identified standardized tests. A study by the authors suggested placement tests such as ACCUPLACER or COMPASS utilized by 2-year colleges were informational in predicting how well a student may perform in a college-level course. However, these tests forecasted achievement in math rather than English and pinpointed if a student had the probability of achieving a course grade of B or better, instead of identifying students who were at-risk of failure. In general, the placement tests did not determine academic progression and achievement for students that were not prepared for college, so colleges need to use a variety of tools for assessment and placement and also administer interventions appropriate to specific needs (Hughes & Scott-Clayton, 2011).

Based on the cut-off scores of the placement tests, students are recommended to take one or more levels of remedial sequence in reading, English, and mathematics. Sometimes students are placed in all three subject areas of developmental coursework. A large number of students may not register in the suggested remedial sequence nor finish it, especially students who may need several remedial courses. Students referred to multiple levels of developmental education are more likely to leave the sequence due to lack of success in the first developmental course (Bailey, Jeiong & Cho, 2008). Also, some students may not register for a gatekeeper course immediately after completing the developmental course. Bailey, Jeiong, and Cho (2008) evaluated student data for 57 Achieving the Dream colleges in Fall 2004, compared the obtained data to 2-year public colleges at national and state levels, and remarked students without strong academic skills took developmental courses for many semesters before attending college courses. Approximately, 40% of the students referred to remedial courses completed the developmental sequence while the remaining students did not. Fifty percent of the total students did not complete the first course in the sequence, which resulted in many of these students leaving the college or not enrolling in a college-level course in the consequent semester (Bailey, Jeiong & Cho, 2008).

According to Bailey, Jeiong, and Cho (2008), at times even when students were advised to enroll in remedial courses, they did not register for these courses nor finished the suggested remedial sequence. The unsuccessful outcomes were not because of a lack of achievement in remedial coursework. Students who required many levels of remediation succeeded at lower rates in gatekeeper courses. However, the achievement rates of gatekeeper courses were neither dependent nor varied based on the remediation

coursework completion, because many students registered in gatekeeper courses instead of developmental courses and performed well in those gatekeeper courses. Jenkins, Jaggars, and Roksa (2009) indicated the placement scores used for developmental coursework recommendation were a better predictor of success in gatekeeper math courses rather than gatekeeper English courses. Overall, students were less likely to register for gatekeeper courses irrespective of the placement scoring or developmental coursework referral. Jenkins, Jaggars, and Roksa (2009) added remedial courses need to be categorized by actual student enrollment in these courses and subsequent failure. The number of students actually referred to remedial coursework and the general success of the remedial courses was not a true measure of remedial success. Furthermore, students recommended to take multiple levels of remedial coursework were less likely to accrue credits, attain a credential, or transition to 4-year colleges (Jenkins, Jaggars & Roksa, 2009).

Even though a lot of importance was given to placement scores, there was a weak association between placement scores and achievement in college courses. Students allowed to enroll in college-level coursework with supplemental instruction provision were able to successfully complete the college courses. The number of students enrolling in remedial education could be reduced by permitting students to enroll in college-level courses by considering the best of either the placement test score or high school success. Scott-Clayton (2012) assessed the placement data of the COMPASS test for more than 42,000 first-time students at a large community college system. The results indicated placement scores of exams were better predictors of achievement in mathematics but not in English. Also, the scores determined by the placement exam were good indicators of

success in college-level courses rather than failure in these courses. Utilizing only high school GPA and course credits for placement generated improved outcomes than the outcomes generated when recommendations were made just by the placement test (Scott-Clayton, 2012).

Many educators strive to help students succeed in higher education by addressing extensive needs of students enrolled in remedial coursework (Achieving the Dream et al., 2015). The postsecondary institutions need to strategize and implement approaches to effectively improve the learning outcomes of students enrolled in developmental education. Six principles were shared to reform developmental education that supported students in higher education and enhanced completion, especially the underserved students. These principles included (1) making students knowledgeable about degree programs that aligned their individual interests to a career with structured academic pathway; (2) enrolling students in credit level coursework in English and mathematics to increase student engagement; (3) providing academic and non-academic support to register in all gatekeeper courses and to improve achievement in these courses; (4) redesigning remedial curriculum so that all the objectives taught in the developmental coursework assisted with success in gatekeeper courses; (5) focusing and integrating curriculum in remedial as well as gatekeeper courses for English and mathematics with course specificity to the chosen program of study; and (6) enhancing associations between academic affairs, student affairs, and institutional effectiveness to share student achievement data so initiatives could be generated and modified according to the analyzed data (Achieving the Dream et al., 2015).

Colleges need other educational avenues for students requiring many levels of remediation. Colleges also need to check why many students did not register in gatekeeper courses and create ways to increase participation in these courses. Students not requiring extensive remediation needed to directly enroll in gatekeeper courses and be provided additional support to enable successful completion in these courses. Community College Research Center studied more than 24,000 students who were enrolled for the first time in either summer or fall semesters of year 2004 within the Virginia Community College System (Jenkins et al., 2009). The remedial and gatekeeper success in mathematics and English, total credits accrued, credential attainment, and transition to 4-year college were assessed for these students. Based on the study results, Community College Research Center suggested Virginia Community Colleges figured out why the students who were referred to remediation did not enroll in those courses. Success in remedial courses was not a true measure of success in gatekeeper courses so approaches needed to be designed by considering the students who were successful in gatekeeper coursework but did not finish the suggested developmental courses (Jenkins et al., 2009).

Kopko and Cho (2013) evaluated almost 15,000 first-time college students who entered one of the eight community colleges in three distinct states during AY 2005-2006. The authors identified when students accumulated nine credits in their program of study, attained a credential, or left college prior to attaining the credential. Students who needed remediation in one or more of the three subject areas of mathematics, reading, and writing were compared with students who did not need any remedial coursework. The results of this study revealed students referred to remedial courses were at least a year behind the students who were not referred to remedial courses. More than half of the

students recommended to take remedial coursework left the college in the second year. The students who transferred to another college gained the credential at the second institution of enrollment, but it was achieved a year behind their peers. The researchers did not investigate if referral to remedial coursework impacted student retention or not.

Community colleges' challenges with developmental education have been discussed extensively; however, there is lack of noted research that evaluated remedial success. Researchers Crisp and Delgado (2013) used data from Beginning Postsecondary Students Longitudinal Study to examine the community college students' effects of remediation on retention and transfer to 4-year colleges. The sample included approximately 3,000 students who were registered in a 2-year higher educational institution in AY 2003-2004, were 24 years old, and had planned to transfer to a 4-year college. Logistic regression analysis identified the odds of a student likely to register in remedial coursework. All the students were classified into developmental and non-developmental groups. The results suggested females and minority students were more likely to register in developmental courses. The students in the developmental groups had a lower grade point average in high school, were less likely to have credits in advanced mathematics courses, and the parents of these students were not likely to have a college degree. The students registered in remedial mathematics courses (80%) at a larger scale than in remedial reading (35%) and English (25%) courses. The difference in retention rate was not observed between the two groups; although, the non-developmental students transferred at a higher rate to a 4-year college than developmental students (Crisp & Delgado, 2013).

In the education arena, the role of remedial coursework within postsecondary institutions has generated varied reviews about the success or lack of success in credential completion. In 1998, Bettinger and Long (2009) examined 28,000 full-time and first-time students who were 18-20 years old and had enrolled at public colleges in Ohio. These students had taken the ACT and had enrolled in a 4-year college or in a 2-year community college near their home with a plan to transfer to a 4-year college. The goal of the study was to assess the effect of developmental education on college achievement and retention so the students' academic progress was noted for 6 years. Results of the study indicated that students who took remedial mathematics and English courses were more likely to persist and acquire a degree in 4-6 years. Students who succeeded in mathematics were more likely to complete a degree in fields related to mathematics. The researchers contradicted the results of available literature and concluded that remedial education was vital to postsecondary education to address the academic gaps of underprepared students. The researchers stated if students were not provided remediation opportunities then they were less likely to be retained at college. However, the researchers concentrated on students requiring marginal remediation and did not consider students who were extremely underprepared (Bettinger & Long, 2009).

According to Lonergan, Snyder, and Rinker (2014), sometimes organizational changes also positively affect the outcomes in remedial and gatekeeper courses in mathematics and English as well as student persistence at college. The researchers stated the administration at Davenport University at Grand Rapids in Michigan incorporated some major organizational changes in AY 2012-2013 to affect the outcomes of students enrolled in developmental mathematics and English courses. The non-pedagogical

changes included students to mandatorily complete developmental education courses in the first semester, assignment of a letter grade instead of Pass/No Credit status, mandatory attendance policy, assessment of student progress at mid-term, and structural supplemental instruction.

Remedial education serves as an exit point for many students rather than this coursework being an entry point at the college. States encounter challenges with respect to remedial education such as lack of comprehensive data, inaccurate assessment tools, a shortage of creative approaches for instruction, and inability to form a connection between state governance and planning (Bailey et al., 2008). However, some states are gathering remedial education data for student enrollment and achievement by implementing innovative models that can improve college success through upscale online environment and classroom technology while lowering educational costs. Bailey et al. (2008) suggested colleges need to strategically keep the remedial students engaged in college by incorporating academic counseling, skills for student success, learning communities, contextualized learning, combining developmental course levels, concentrated advisement, enrolling developmental students in college-level coursework, and providing supplemental instruction (Bailey et al., 2008).

Sequential and Accelerated Teaching Models

The Cognitive Learning Theory actively engages the learner in the learning process and is based on areas of cognitive sciences such as psychology, neuroscience, biology, and philosophy (Ertmer & Newby, 1993). This theory incorporated integrating gained knowledge and prior learning by logically receiving, organizing, and retrieving the subject matter. Instructional designers facilitated and enhanced learning by

identifying and designing targeted instructional approaches. The instructional techniques can be strategically based on specific learning theories and implemented accordingly (Ertmer & Newby, 1993). Although, the academic accomplishments of students who had learning and cognitive deficiencies and were at-risk of failure was not enhanced by education concentrated on cognitive instruction, cognitive instruction integrated with academic intervention generated successful outcomes for students who prior had lower achievement rates (Kearns & Fuchs, 2013).

According to Mayer (2002), traditional instruction delivery was done verbally, which included lectures and printed materials in the form of textbooks. The cognitive theory of multimedia learning stated that through multimedia, narrative, and animated presentation; psychologically a student associated both the components of presentation and gained a better understanding of the taught concept. The new concepts got integrated with prior learned concepts. The principles of cognitive theory for multimedia learning were noticeable in computer-based learning. However, Mayer cautioned both the narrative and animated components of learning needed to be presented concurrently instead of consecutively and any extra narrations, sounds, animations, and text on the screen needed to be omitted to avoid distractions from learning focus. The presentation had to be personalized, emphasized, and needed to include active learning activities.

Lau (2014) defined computer-based teaching module as a teaching approach utilizing a multi-media platform to deliver instruction. The theoretical benefits of computer-based teaching module included learning imparted across multiple avenues so students' different learning styles could be accommodated, students could learn at any time, and students could also decide the pace at which the concepts could be mastered.

One of the drawbacks of this type of teaching delivery was the lack of interaction between the student and teacher. Also, an instructor was not available to explain or clarify the content as learning did not happen in the presence of a teacher.

Typically, course delivery of online and hybrid platforms involve usage of technology to impart partial or full course instruction. Zavarella and Ignash (2009) studied students registered in remedial algebra coursework delivered through traditional, hybrid, or online environments. These students' gender, age, and ethnicity for each delivery platform were characterized. The results revealed students registered in hybrid or online courses were twice as likely to withdraw in comparison to students enrolled in the traditional environment. Although, students registered in these courses for personal reasons were more likely to successfully complete the coursework. The achievement status in the course was not impacted by the learning styles and scores of the college placement test. Jacobsen (2006) emphasized computer-based learning or reinforcement did not have a significant impact on student learning outcomes so technology usage needed to be approached with caution.

Many times students take multiple semesters to complete the recommended remedial courses. Acceleration models are designed with an aim to reduce the time taken to complete developmental course work so students can do well in the recommended courses within their chosen program (Edgecombe, 2011). Edgecome (2011) reviewed empirical studies that measured achievement and completion data and gave an overview of various acceleration models incorporated at different colleges and also discussed how to address the encountered challenges while offering two main models identified as Course Restructuring and Mainstreaming. Course Restructuring fastened remedial

coursework termination sequence by linking college courses through structured curriculum to enable students to complete two or more courses in a single term; providing developmental and college complementary content as a pair; redesigning curriculum that decreased the levels of developmental coursework; or converting developmental subject matter into modular form. Mainstreaming boosted student achievement by enrolling students in college-level courses instead of developmental coursework and by providing supplemental support or by contextualizing foundational skills (Edgecombe, 2011).

Challenges that hindered student progression with respect to acceleration models involved (1) stringent student assessment and placement in developmental coursework through standardized tests, even though these tests have major limitations; (2) systemic or an individual college curricular framework for implementing these models without proper competency alignment; (3) lack of strategized marketing to recruit students and enroll them in accelerated programs; and (4) lack of faculty participation in innovative acceleration approaches (Edgecombe, 2011). Although limited, acceleration strategies seemed to elevate the learning outcomes of students identified as needing remediation. Educators and policymakers strived to reform and implement acceleration models through radicalization of current policies and processes and pioneering interventions that generated exceptional student learning outcomes in community colleges (Edgecombe, 2011).

Venezia and Hughes (2013) added acceleration approaches in remedial education were implemented to not only lessen the time taken to complete the coursework but also to enable quicker enrollment in courses required for credential attainment. One of the other benefits of acceleration approaches was the elimination of additional stop points for

students so they could advance academically. These approaches included co-enrollment in college courses, lessening the number of course sequence, or modular coursework. The co-enrollment courses enabled the student to register for courses that could be transferred and also get extensive educational support. Redesigned coursework had modified curriculum that aligned required skills, which a student had to learn. Modularization categorized traditional coursework into modules focused in specific objectives identified through diagnostic measurements. The drawback of modular coursework was sometimes disintegrated content, which may affect success in college courses. Also, modular coursework was inappropriate for students lacking effective time-management skills (Venezia & Hughes, 2013).

Approaches to Remedial Education in Various States

Congress requested the United States Department of Education to generate a statistics report identifying the access and completion gaps in higher education so explicit policies can be formulated to address these gaps. The NCES report in 2012, *Higher Education: Gaps in Access and Persistence Study*, analyzed these gaps in detail categorized by gender and race (NCES, 2012e). Some of the factors responsible in a student leaving the college without attaining a credential were financial constraints, lower remedial and academic success, lack of proper educational and social adjustment, part-time enrollment status, enrollment discontinuity, Pell Grant receipt, working less than 15 hours per week, and starting at 2-year college rather than 4-year college. The educational experiences of the twelfth-graders across the nation attending college in the year 1992 depicted students enrolled in developmental coursework were less likely to complete and attain a credential (NCES, 2012e).

Many approaches were implemented to help students complete remedial coursework, prior to college enrollment. These approaches include high school students being allowed to concurrently register for college-level courses, college placement exam administered and followed by needed targeted instruction to better the college readiness, and college freshman being taught required remediation skills prior to starting college coursework. Even though colleges across the nation practiced such approaches, there was sparse evidence supporting these approaches' role in eliminating developmental education and subsequent achievement in college courses. An important aspect of developmental education was the multi-levels of required remediation in reading, English, and mathematics, which a student had to take as pre-requisite to college coursework. Sometimes completion of developmental education took many semesters which prolonged the degree attainment span. In order to advance at a faster rate through remedial courses, some colleges delivered selective remedial skills, self-placement learning through modular coursework, or college-level course enrollment with additional support provision (Rutschow & Schneider, 2011). Acceleration approaches tended to enhance student success, although more studies need to be conducted to determine the correlation between student achievement and progression with respect to the program offerings (Rutschow & Schneider, 2011).

Texas higher education introduced the Texas Initiative System to generate effective pathways to prepare students in fulfilling their remediation requirements and succeed in college-level courses (Texas Higher Education Coordinating Board, 2014). Texas funded Developmental Education Demonstration Projects to improve remedial education across the state by providing a structure in various components that affected

remedial success. Instead of using COMPASS, ACCUPLACER, Asset, or Texas Higher Education Assessment for placement, the Texas Success Initiative Assessment was launched. This instrument could be adapted on the computer and dependent on the student's answers, the questions could be adjusted at appropriate levels to gauge student knowledge about the subject matter. The students deemed to be needing remediation were given a diagnostic test, which identified the objectives a student had to master. The colleges were provided with information to place the student in explicit courses that enhanced student learning outcomes. The higher education institutions in Texas also ensured targeted advisement while considering student's prior academic experiences and successes as well as non-scholastic aspects. The state also designed the Integrated Reading and Writing for existing program-ready courses and afforded the faculty and staff with appropriate resources for successful implementation. Colleges developed explicit interventions based on the competencies, which the student had to learn and these Non-course Competency-Based Options adjusted the course contact hours as per the student needs. The students addressed the remediation needs by enrolling in a co-requisite model, a Math Pathway model, to be prepared for credit level courses (Texas Higher Education Coordinating Board, 2014).

The state of North Carolina has 58 community colleges and each college used their own placement criteria to identify students with academic deficiencies. In 2009, the community colleges were pivotal in imparting remediation competencies to more than 60% first-time credential-seeking students enrolled in at least one remedial course and 33% students enrolled in two or more remedial courses. Clotfelter, Ladd, Muschkin, and Vigdor (2015) considered students who took the eighth grade state mandated tests in

1999 and joined a community college in North Carolina between year 2001 and 2009. The authors examined more than 17,000 students and recorded if these students received free lunch, the parents' educational attainment, and if these students were gifted or disabled. The results of the regression discontinuity model indicated almost half of these students enrolled in a developmental mathematics course and 40% of these students never took a college-level mathematics course. The success rates of remedial students passing the college-level mathematics course were 32%, while the success rates for remedial English course was 55%. The results indicated developmental coursework did not affect student's enrollment in the next term. Females who took developmental courses were less likely to succeed in college-level courses in comparison to male students; however, males performed at a lower rate in mathematics courses. The remedial students from higher socio-economic areas were less likely to perform well in college-level courses than remedial students from lower socio-economic areas. In short, traditional students in community colleges in North Carolina did not enhance their foundational skills by enrolling in developmental coursework nor increased their chances of succeeding in college-level coursework or in credential acquirement. The researchers recommended in order to be well-prepared for college, high school students needed to be provided with additional approaches that enabled them to lessen the academic gaps, while they were attending high school only (Clotfelter, Ladd, Muschkin, & Vigdor, 2015).

The state of Washington changed community and technical college funding from enrollment to performance through the Student Achievement Initiate (SAI) (Washington State Board for Community and Technical Colleges, 2012). The funding was dependent on student achievement in credit-level mathematics, first year in college, and acquiring a

credential. Additional funding was given to colleges if the student mastered basic skills in reading, English, and mathematics as assessed by a nationally accredited test or gained a high school diploma or equivalent certificate; finished remedial course work in English or mathematics course and a credit-level course; accomplished 45 college credits in one year; succeeded in five credit-level mathematics courses; or acquired a credential (Washington State Board for Community and Technical Colleges, 2012).

The state of Connecticut passed a legislative bill that eliminated remedial education from the state's colleges (Young, 2012). The remedial course work was replaced by additional academic support such as tutoring lab and other program enhancing college readiness. According to Young (2012), colleges and high schools were recommended to align the academic curriculum for a seamless transition. One of the professors voiced concern remedial education removal would enable students with academic deficiencies to be placed in college-level courses for probable failure and eventual departure from the college. Also, continuous reenrollment in credit courses would not be cost-effective for the student or the institution (Young, 2012).

Acceleration approaches in remedial coursework lessened the opportunities for students to drop out of the remedial coursework sequence and shortened the time taken to complete remedial coursework (CCRC, 2014). Although, faculty tended to question if accelerated approaches rightly addressed the academic deficiencies and actually prepared the students for credit-level coursework. The Community College Research Center (CCRC) reviewed successful student completion or required gatekeeper courses and credit accumulation of credit-level courses for students enrolled in the accelerated model for developmental courses. The students who took accelerated classes at the Community

College of Denver in Colorado, enrolled at a higher rate in gatekeeper mathematics course and there was not a significant difference in the success rates of these students in comparison to students who did not enroll in an accelerated model. Also, the students in the accelerated model did not register for more credits than the students in the traditional sequence. Similar results were observed at Chabot College in California except the students enrolled in the accelerated model had accumulated more credits for college-level courses. The students at the Community College of Baltimore County in Maryland implemented the co-requisite model for English courses, where supplemental instruction incorporating developmental writing skills was given. The results showed the students in the Accelerated Learning Program registered and completed gatekeeper coursework at a higher rate and also acquired more college-level credits (CCRC, 2014).

In the state of California, the California Community Colleges Success Network initiated best practices accelerated model for English and mathematics courses (Hayword & Willet, 2014). The California Accelerated Project (CAP) enabled flexibility in launching the model but provided framework for combining two or more levels of traditional coursework into a single course, the gatekeeper course. All the students enrolled in the accelerated course had to enroll in a college-level course, upon successful completion of accelerated coursework. The colleges also received guidelines to design challenging and engaging projects in the transfer level course, which extensively developed basic skills and enhanced contextual applicative and critical thinking skills. Hayword and Willet (2014) measured the student outcomes enrolled in CAP during the first year. The two groups of students examined for this research were students who were enrolled in the accelerated project and students who were enrolled in the traditional

sequence. Eighteen accelerated pathways at 16 different colleges in AY 2011-2012 were considered in this study and data were collected for almost 2,500 students. The multivariate logistic regression model revealed that the students enrolled in the accelerated course in comparison to the students enrolled in the traditional sequence were 1.5 times more likely to complete the gatekeeper course in English and 4.5 times more likely to complete the gatekeeper course in mathematics. Asian students were more likely to complete the English and mathematics sequence, while African-American students were less likely to complete the sequence; as compared to White students. The receipt of Pell Federal Grant did not have any significant impact on the sequence completion. Overall, students enrolled in the accelerated model indicated a significantly successful impact on completion of gatekeeper courses, irrespective of ethnicity, gender, and receipt of Pell Grant (Hayword & Willett, 2014).

In the state of New York, the City University of New York Community Colleges designed their own developmental sequence with varying number of credit hours for these courses (CCRC, 2014). The students enrolled in shorter sequential mathematics could pass the gatekeeper mathematics course at the same rate as the students in the longer mathematics sequence, but overall acquired fewer college-level credits. However, the students enrolled in the shorter sequential English course did not succeed at the same rate as students enrolled in a longer sequence, but acquired more college-level credits. CCRC (2014) recommended encompassing activities and objectives in remedial curriculum so students can enhance the necessary foundational skills. They further suggested colleges to provide additional services such as tutoring, necessary interventions identified through early-alert system, and instructor collaboration (CCRC, 2014).

In the state of Washington, Jenkins, Zeidenberg, and Kienzl (2009) examined 24 colleges that offered the I-BEST program to improve the success rates of students enrolled in higher education for vocational training. Instructors teaching foundational and vocational competencies collaboratively developed "workforce" courses in contextualized learning. The program contradicted the traditional mindset that students cannot succeed in college-level courses without completing the foundational skills. The learning outcomes of 900 I-BEST students and a total of 31,000 foundational skilled students in academic year 2006-07, were considered in this study. The results indicated the I-BEST students academically progressed at a higher rate in college-level vocational programs though it cannot be definitely stated that I-BEST model was causal in creating exceptional outcomes due to the way in which I-BEST students were selected. Additional research was recommended to examine degree completion and workforce data, fiscal gains, and policies of the I-BEST program that generated exceptional outcomes.

Rutschow and Schneider (2011) mentioned that some of the approaches piloted and evaluated by various community colleges to enhance remedial success were contextualized learning and learning communities. Additional supportive models to improve student success such as supplemental instruction, focused advisement, and early-alert systems incorporation were also considered. Contextualized learning created avenues for students' learning foundational skills through integration with other academic courses in the program of study, which resulted in improving learning outcomes, especially in technical programs. Contextualized learning proved to be instrumental in aiding students to learn the foundational competencies and progress successfully in

college-level courses to earn credential in a timely manner (Baker, Hope, & Karandjeff, 2009).

According to Zhao and Kuh (2004), creation of a learning community linked remedial and college-level courses to enhance student engagement in mastering the required skills as well as building student relationships with each other and the college. A well-planned learning community showed positive learning outcomes; nevertheless, collaboration somehow lessened overtime as students parted ways upon learning community program completion (Zhao & Kuh, 2004). Peers conducted supplemental instruction sessions for additional instruction in courses with lower success rates. Typically, peers incorporated active learning strategies to increase student engagement and generate successful educational outcomes (Xu, Hartman, Uribe, & Mencke, 2001).

Xu et al. (2001) recorded focused advisement, complementary instruction, and courses of student achievement showed effectiveness in enhancing remedial success, but additionally have not enabled faster credential attainment. Research studies portrayed many approaches such as supplemental instruction, compartmentalized coursework for fast-tracking remediation, and contextualized developmental integration within technical programs that lessened time to complete remediation and aided in college-level coursework success. Xu et al. (2001) also noted the success was for a very small percentage of the actual number of students enrolled in remedial programs and the achievement effects were relatively small to substantiate future continual success, which indicated bold measures were required to revamp remedial success. The researchers felt organizations needed to check the admission criteria for remedial coursework admittance and also develop ways to train the faculty teaching remedial courses, specifically adjunct

faculty, who typically were more likely to teach remedial courses. More empirical studies conducted to measure the efficacy of innovative programs in remedial education and results signifying explicit program intricacies need to be shared to understand the factors that actually affect remedial success (Sperling, 2009; Zachary & Schneider, 2008).

Bettinger, Boatman, and Long (2009) specified remedial students were supported by summer bridge programs, cohort enrollment through learning communities, mentoring, tutoring, workshops targeted to improve study skills and time management, intrusive advising, and academic counseling. The goal of the higher education institutions was to help students transition and navigate college successfully. Although, these support services aided in initial academic achievement and advancement, it is difficult to clearly identify which specific support services played an instrumental role in the student's progress. An all-encompassing advisement that managed academic and non-academic hindrances could increase college persistence; however, there is no evidence on long-term effects of such advisement and ability to scale these services to other student groups.

A defined structure, first-year transition integrating coursework, directed advisement to address non-academic and individual factors, and supplemental tutoring for traditional remedial coursework together significantly affected student achievement and persistence at college (Fowler & Boylan, 2010). Fowler and Boylan studied almost 6,000 students at a 2-year public college to evaluate the impact of the Pathway to Success Program (PWAY). A group of students enrolled in Fall 2003-Spring 2004 who were not enrolled in the PWAY Program were compared with another group of students enrolled in the fifth year of PWAY Program, in Fall 2008-Spring 2009. The student attributes in both groups were similar. The students enrolled in the PWAY Program had to attend

orientation; had to sign an achievement contract to accept advising, tutoring, and attendance mandates; had to follow the given schedule; and had to finish developmental coursework that included transition classes in reading, developmental English composition, and developmental mathematics. There were designated advisors who discussed non-academic and individual achievement aspects as well as short- and long-term goals. An early-alert system was also in place for immediate intervention implementations. The students had to go for tutoring if a grade below C was received in an assessment. The mean GPA, academic standing, remedial coursework success, and retention rates were much higher for students in the PWAY Program (Fowler & Boylan, 2010).

Typically, low skilled students encounter fiscal and societal issues that hinder educational attainment (Bragg & Barnett, 2009). Bragg and Barnett (2009) examined 1,363 students from 2006-2008 who initially participated in Breaking Through (BT) programs in 16 colleges that received funding to either implement these programs or participate in the professional development sessions generated by these programs. The BT program was designed to increase the college access of students with low-level skills by integrating continuing education, remediation, technological education, and vocational planning in various community colleges spread across the United States. Various colleges implemented the BT program differently such as enabling the students to gain apprenticeship or credential through contextualized remediation, acceleration of remedial sequence to advance in degree-level coursework, graduate more students in health care and industrial coursework through contextualization and supplemental instruction. The students enrolled in the BT program had high school graduation equivalency but still had

been referred to complete remedial coursework before taking the gatekeeper courses. Through the BT program, the students successfully passed gatekeeper and other college-level courses.

Goudas and Boylan (2012) examined several studies and contended the results depicted off these studies about remedial students' lack of success were flawed and policies need not be created based on these results. According to the researchers, it was wrong to expect students taking remedial courses to do better in gatekeeper courses and other assessment areas in comparison to non-remedial students. Also, two of the studies examined were based on students who scored just below the cut-off scores in a placement test and these studies need not be generalized. The students who took remediation in mathematics and English courses and passed the gatekeeper course needed to be noted as remedial coursework success. Furthermore the authors stated, the remedial success needed to be counted as developmental education generating outcomes as it was supposed to generate. Instead of portraying that remedial education did not positively impact college success, it had to be concluded the conducted studies depicted mixed results. The money spent on remedial education should never be an issue nor cited by data as education provided avenues for societal progress and viability and instead be given the utmost importance (Goudas & Boylan, 2012).

Goudas and Boylan's criticism was defended by Bailey, Jaggars, and Scott-Clayton (2013) about the studies conducted by Community College Research Centre (CCRC). These studies considered students who were program ready but some of these students were enrolled in remedial coursework whereas some were not. The results indicated the remedial students had similar or sometimes worse impact on retention and

success in college courses, thus signifying the ineffectiveness of remedial coursework. The sequences in remedial coursework may have enhanced the academic proficiencies but these sequences tended to screen out students who were less likely to have proper support outside of the college environment. The students who were referred to the highest level of remedial coursework may have benefitted from a co-requisite model with supplementary academic and non-academic support. The accelerated remedial coursework provided necessary basic skills in a short time frame so students could perform well in college-level courses. Irrespective of academic deficiencies, at the onset, colleges needed to provide support services to integrate students in program level coursework. There was a necessity for reforming the overall remedial education in the areas of placement, evaluation, high school and college curriculum, financial constraints, early alert system, and student support systems (Bailey et al., 2013).

Remediation in Mathematics Coursework

The students and adults in the United States of America were compared with other countries in the world in various literacy assessments, which measured the educational acquirement capability, influence of education on their economic status, and overall competitive standing across the world. The Program for International Student Assessment (PISA), coordinated by OECD, assessed literacy in reading, math, and science of 15-year olds in more than 70 countries (NCES, 2015a). To check the applicative knowledge in the subject matter, the assessment of practical skills that students mastered at the end of mandatory school year was administered. The mathematics literacy measured the student's ability to apply critical thinking skills using various mathematical concepts. The results were depicted in mastery levels of 1-6 and

scale scores of 1-1,000. The United States had a mean score of 481, which was 13 points below the OECD average. According to the OECD Survey of Adult Skills, a higher competency in mathematics has been indicative of students participating in postsecondary education and getting well-paid jobs (NCES, 2015a).

A country's knowledge base could be gauged by the education levels of its citizens, especially within the area of sciences, engineering, and technology. These disciplines relied heavily on mathematics so it was befitting to focus on accomplishment of mathematical skills at secondary and postsecondary levels. Unfortunately, higher educational institutions across the world experienced a decline in the foundational skills in mathematics for incoming students at the college level (Faulkner, Hannigan, & Fitzmaurice, 2014). The increase in educational access within the postsecondary arena was cited as one of the major reasons for the evident gaps to be noticeable. The evident mathematical deficiencies not only affected college success but also affected the nation's economic success (Faulkner, Hannigan, & Fitzmaurice, 2014).

According to NCES (2012e), 2007-08 data portrayed that 29% of students took developmental courses at 4-year colleges, 41% at 2-year colleges, and 28% at less than 2-year colleges. Additionally, successes in advanced mathematics courses played a prominent role in college success, degree completion, and income as there was a high correlation between high school achievement, college retention, and employment. It was noted students who joined college in 2003-04 were 40% more likely to attain a credential if they took algebra II or trigonometry and 93% more likely to complete a credential if they took pre-calculus or calculus in comparison to students who did not take these courses (NCES, 2012e).

Developmental education's low success rates, cost, and non-transferability of credits could push students to drop out of college (Merseth, 2011). The Carnegie Foundation collaborated with faculty, researchers, administrators, students, and policymakers to modify developmental components (Merseth, 2011). In 2009, Statway was designed, which targeted credit-level statistical objectives inclusive of appropriate basic mathematical concepts. This coursework was explicitly tailored for students on the non-STEM (science, technology, engineering, and mathematics) track, but met the conceptual needs of various program of studies. The students were trained with problem-solving and analytical skills for data summarization. In the year 2010, another non-STEM pathway called Quantway was created, which targeted knowledge and application of mathematical competencies. Both Statway and Quantway enabled community college students needing multiple levels of remedial mathematics coursework to actively and quantitatively learn the required skills to succeed in the chosen program of study. These courses also incorporated explicit support services and pedagogical strategies to enhance the learning outcomes, enable college navigation, increase self-ability, boost motivation, and effectively heighten persistence at the college (Merseth, 2011).

Upon enrollment in a college, students are recommended to take remedial math courses based on the results of the placement test in algebra. The students in the K-12 system are encouraged to study algebra so they could be well prepared for college admittance and career preparedness (Eddy et al., 2015). Students were to be taught algebra to compete globally, generate equal opportunities for all students irrespective of race, meet requirements in K-12 curriculum, and for evaluation of high school mastery in algebra. Eddy et al. (2015) studied the curriculum and evaluation framework to learn

about the algebraic concepts taught in schools. The Algebra for All focused on students who needed to study algebra and the concepts in algebra that needed to be taught so students could find solutions to modeling problems, unifications of algebraic concepts to achieve, and form quantitative associations. Eddy et al. assessed and aligned the student learning outcomes in algebra from nine distinct frameworks identifying the main themes in algebra for analyzing the obtained data. The four main ideas identified with respect to content were variables, functions, patterns, and modeling. The two main ideas noted with respect to learning processes were technology and multiple representations. The researchers concluded students taking algebra before and in ninth grade gained relevant math foundation required for college. Algebra unification would give guidelines to stakeholders involved in designing academic policies and in considering common ground in evaluation, research, and curriculum make-up (Eddy et al., 2015).

The importance of mathematical courses in postsecondary education was not properly defined for students to understand the relevance of learning various objectives in mathematics. One of the motives behind teaching mathematics was garnering critical thinking and reasoning skills in students (Jorgensen, 2010). This was difficult to achieve with an extensive content incorporated in mathematical coursework, as students memorized the facts without actually realizing the applicative concepts. Jorgensen (2010) noted this and identified five avenues such as Motivation, Relevance, Depth, Pedagogy, and Textbooks, which have remained unchanged in the past centuries and do not portray any progressive developments. The students were not motivated nor put the required efforts to perform well in mathematics coursework. Curriculum in mathematics had to be redesigned such that the conceptual categories were condensed but still encompassed in-

depth objectives. Jorgensen (2010) suggested curriculum in developmental coursework need to be imparted by active or student engaged learning. The developmental textbooks need to incorporate better examples with easy to understand language and explanations so students can practice the learned concepts easily.

Identifying differences in associations between student attributions and academic outcomes amongst traditional and non-traditional students aided colleges to launch teaching strategies that heightened student success in developmental and credit bearing coursework in mathematics. The success of non-traditional students in community colleges could be targeted to increase the academic achievement in developmental courses and enhance the overall credential acquirement (Dasinger, 2013).

Faulkner, Hannigan, and Fitzmaurice (2014) studied data for students in science and technology fields from 1998 to 2008. The students were categorized as standard or nonstandard, which followed the definition of traditional and non-traditional classification. Gender, prior achievement in mathematics, program of study, performance of each student in the diagnostic test, and test profile dependent on the given answers were noted for each student. Earlier achievement in mathematics was perceived to be the most important predictor of college-level performance in mathematics. The results of the study indicated remedial education was needed for students to get a fair chance of succeeding in the program of study, especially in degrees requiring mathematics. Also, educational institutions needed to intervene prior to student's departure from the college.

Moreover, instructors were required to incorporate culturally sensitive teaching approaches. These approaches were to portray the applicative components of mathematics so students could understand the importance of mathematical competencies.

Walker and Plata (2000) concluded this through chi-square analysis for 500 students with algebraic deficiencies at a 4-year university. The students were categorized by gender, age, and ethnicity and the grades in developmental mathematics were classified as pass or fail. The results signified males were less likely to fail courses in fundamental mathematics and elementary algebra. The students above 26 years of age were more likely to pass fundamental mathematics and less likely to pass intermediate algebra.

The students were more motivated when they realized content mastery in mathematics was relative to their academic success and progress. They understood the applicative aspects of mathematics, practiced problems in homework, visited the tutoring center, and met the instructor during office hours for one-on-one reinforcement. The instructors needed to be more vigilant about student engagement and were to take extensive measures to address students' lack or success and motivation in mathematical coursework as soon as it occurred. Howard and Whitaker (2011) conducted a phenomenological study on a student viewpoint from turning their prior unsuccessful learning to successful learning in developmental mathematics course. The 14 students included in this study were interviewed, observed in the classroom, and evaluated through exam, quiz, or homework scores. The researchers also kept a journal for these students. The three themes derived and investigated for successful and unsuccessful experiences were Turning Point, Motivation, and Strategies. The Turning Point occurred when students first encountered their unsuccessful experience, which affected their ability to learn the mathematical concepts. The students hated and feared mathematics during this period and did not put in the time and effort to master the concepts. The Motivation was two-fold as the student's dislike in the unsuccessful experience changed

to a liking for the subject in the successful experience. The students' perception of their own inabilities to learn the objectives changed from incapability to capability. The students changed their thought processes and studying habits within the Strategies theme.

Success in a prior mathematics course is deemed to increase self-efficacy in mathematics as this success is attributed to heighten individual abilities and efforts (Hall & Ponton, 2005). A student may lack confidence to pursue majors requiring extensive mathematical coursework, especially if the student was earlier unsuccessful in mathematics. Hall and Ponton (2005) examined the differences in mathematics self-efficacy scale scores of freshmen students enrolled in intermediate algebra and calculus courses at a Southeastern University. The results of the study indicated that the students enrolled in a non-developmental calculus course had an increased self-efficacy in mathematics in comparison to the students enrolled in an intermediate developmental algebra course. Instruction could be targeted to boost the self-efficacy of students and in turn provide additional self-gauging capabilities (Hall & Ponton, 2005).

According to Bahr (2010), sometimes students with large academic deficiencies may not be leaving college but may be remediating at lower rates than students with fewer academic deficiencies. Students may just drop out or shift to alternate programs that do not mandate credit-level mathematics success. A strong association exists between race, achievement in first mathematics course, and remediation coursework. The ethnic differences noted in mathematical skills upon college entrance and achievement in the first mathematical course affected these differences in successful remediation too. Bahr (2010) studied the racial disparities within community colleges in California with respect to successful remediation in mathematics, which entailed passing a credit-level

course in mathematics. Students enrolled for the first-time in Fall 1995 across 104 community colleges were followed for 6 years. A logistic regression model was used to analyze the likelihood of successfully passing a credit-level mathematics course within 6 years of college admittance. The results of the study indicated Black and Hispanic students were less likely to remediate successfully. The study results could not pinpoint the reasons why students with high remedial needs did not successfully complete the remedial mathematics sequence. The success rates of attaining credits in mathematics courses within 6 years was approximately 25% for Whites, 33% for Asians, 20% for Hispanics, and 11% for Blacks. Blacks and Hispanics with low success rates in mathematics from secondary schools achieved similar results in remedial coursework in mathematics at postsecondary level (Bahr, 2010).

Lack of foundational knowledge in mathematics can also be responsible for student withdrawals in mathematics courses and can affect student attrition (Jones, Price, & Randall, 2011). Jones, Price and Randall (2011) conducted a study to determine foundational mathematics skills for students enrolled in business statistics and quantitative analysis classes at an accredited Southern University. The students were given problems that included basic arithmetic and algebraic concepts such as decimals, percentages, substitution, and evaluation. The students had to complete the problem in 10 minutes and could not use calculators for solving the problems. Any student who had passed tenth grade would have been able to do well in the assigned problems. Initially, this study was conducted among 91 students enrolled in business programs. Results indicated that 13% of these 91 students were successfully able to answer all 15 problems. The study was expanded to totally 230 students in a statistics class and 181 students in a

quantitative class. All these students were given the impromptu problems in the first 2 weeks after the semester started. A student could either answer the problem correctly or incorrectly as students were not given any partial credit. The initial group, statistic student group, and quantitative analysis student group were compared for each of the problems. Comparison was made of overall mean and median percentage of the rightly marked answer for each discipline and the overall mean percentage was checked for significance through ANOVA. The test score was also matched to the end of course letter grade earned by the student. The authors had postulated that there was not any significant difference between the disciplines for the considered groups. Results indicated, contrary to the hypothesis, the mean student performance and the final class grades were significantly different. Faculty needed to be cognizant of the skills gap and their effect on student successfully completing courses that required critical thinking (Jones, Price & Randall, 2011).

Bahr (2013) studied 190,637 California Community College System students who did not complete the recommended remedial mathematics sequence or the college-level mathematics course, nonetheless still stayed enrolled in the college. The selected population consisted of first time Fall 2002 students enrolled in 105 community colleges in California. The cohort of almost 80,000 students, were (1) not simultaneously admitted in high school in Fall 2002; (2) not transfer students; (3) did not have a prior higher education degree; (4) had not been a part of a 4-year college 5 years prior to Fall 2002; (5) had a legitimate Social Security Number on file; (5) registered in one semester after Fall 2002; and (6) had taken a non-technical math course.

Improvement of academic success in remedial mathematics sequence for community college students was correlated to success in college-level mathematics, but more importantly in overall student success in credential attainment (Bahr, 2013). Efforts to better success rates in mathematics affected student completion of credential and transferability to 4-year colleges. However, students who are unable to finish the remedial mathematics sequence were to be encouraged to achieve other educational credential without college-level mathematics success such as vocational certification. In the considered cohort, more than 65% of students who did not complete college-level mathematics course continued enrollment in the community college, but 84% of these students did not attain any credential or did not shift to a 4-year college, which translated to a big loss of students within the community colleges. The study reflected upon the credits attained and success rates noted amongst students who did not finish the mathematics sequence and indicated the early exit as an overall "slippage" instead of a cause so remedial restructure may not solely address the student retention and completion issues faced by community colleges (Bahr, 2013).

Waycaster (2011) compared the achievement rates of students who directly enrolled in a gatekeeper mathematics course with students who completed remedial mathematics course and enrolled in a gatekeeper mathematics course within a year. The achievement rates were defined by a course grade of C or better. The results suggested the achievement rates of both groups of students were the same in the respective gatekeeper course thus signifying that remedial coursework did prepare students to perform well in the gatekeeper course. The study also portrayed students who took the

remedial mathematics course online did not perform as well as the students who took this course in a face-to-face environment.

Mesa (2012) studied 777 students who took developmental and credit courses in mathematics at a community college in the Midwest. Twenty-five instructors gave the students a survey after the sixth week of the semester. The courses in which the survey was administered were scheduled on various days and times. The survey gauged demographic details and information on prior math courses, completion rates, educational goals, job rates, financial aid receipt, and student re-enrollment in a math course. A large percentage of students in the sample were white, female, between 18-21 years of age, single, were not responsible for kids or family members, high school graduates, and received financial support from loans, grants, and family. The students also shared their experience in taking the math course at high school and the two math courses at the college. Instructors were requested to predict the score of their students and give explanation as to why they predicted that score. Instructors were given the actual scores after their predictions. Instructors also analyzed the variance between their predictions and the actual scores. Mesa found that students believed that they can learn the challenging concepts by working hard and anticipated their instructors to give complex problems. Students enrolled in developmental mathematics courses were deemed to be more motivated than students enrolled in higher level mathematics courses. Interestingly, instructors predicted their students' motivation and mastering concept capability at a lower level in comparison to their students. Results portrayed by this study can be useful to institutions in training their faculty to have realistic but high expectations of their

students so they can strive to do more in the enrolled courses than the minimum requirements in competency standards.

Chingos (2016) examined more than 8,000 students from 2008 through 2011 at Glendale Community College in California. These students were enrolled in remedial algebra classes and took the common final exam. Instead of observing student characteristics that enabled successful learning outcomes, Chingos observed instructors' characteristics such as instructors' education levels, employment status, and teaching experiences at the college. A regression model was formulated to estimate the correlation between student outcomes in the remedial courses and the instructor characteristics. The results indicated students taking a course with a full-time instructor holding a master's degree performed better than those enrolled in an adjunct instructor's class or with an instructor holding a doctoral degree (Chingos, 2016).

Success in program coursework and degree requirement can be increased by providing specific instruction and support as required by individual student needs rather than massive approaches implemented to address multiple student needs (Li et al., 2013). Postsecondary institutions do not need to incorporate various strategies to assess students' skills and provide services to tackle these deficiencies. Li et al. (2013) examined the readiness in mathematics and role of attendance and engagement of students enrolled in remedial mathematics courses. These factors were measured to predict the concepts learned in mathematics, wherein the students successfully completed the course. The results indicated successful outcomes could be generated by integration of academic skills and efforts put in by the students in developmental mathematics courses.

Developmental courses served as a hindrance to college completion for many students (Bonham & Boylan, 2012). Even though, students passing developmental coursework were more likely to succeed in college, many students did not complete remedial coursework, especially in the subject area of mathematics. Bonham and Boylan (2012) noted educational institutions were constantly designing and developing innovative approaches that could enhance success in developmental mathematics coursework. However, an extensive alliance was needed amongst educators and policymakers to propel these efforts into outstanding and successful outcomes. Higher education institutions in the United States did not have a choice but to do everything possible to avail opportunities to students enrolled at their institutions so they can pursue their educational goals of achieving a credential (Bonham & Boylan, 2012).

Summary

This chapter illustrated the body of literature available for remedial education and the challenges faced by colleges and universities across the country in improving the success rates of students enrolled in developmental coursework. Although, innovative approaches are designed and developed very frequently, a major progressive structure has not been established to enhance academic achievement for students with academic deficiencies. The next chapter describes in detail the methodology followed for data collection and data analysis for this study.

Chapter III

METHODOLGY

The purpose of this study was to determine if there is a difference in student performance in the gatekeeper mathematics course and the number of semesters taken to complete the graduation requirements when similar students enrolled in an associate degree program either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by the Technical College System of Georgia. Student performance was represented by a course grade of C or better.

The students considered in this study were referred to remedial coursework and had enrolled in either the accelerated redesigned mathematics course or the traditional mathematics sequence. The researcher identified if students registered in the redesigned course took fewer number of semesters to attain an associate degree and were able to graduate on time. The academic performance of all remedial students was examined to check if the content learned in either of the remedial coursework model affected the success in the gatekeeper mathematics course, as measured by a course grade of C or better. Determinations were also made about specific student characteristics that served as predictors in attaining the associate degree. This chapter describes in detail the participants selected for research, research questions, and the methodology used to identify if any significant differences exist between the student groups that correlates to degree achievement. Additionally, information about the conceptual framework, data collection, and data analysis are presented.

Research Questions

The following research questions will be addressed in the study:

RQ1: Is there a significant difference in the pass rate of gatekeeper mathematics course for students enrolled to earn an associate degree taking the accelerated remedial mathematics course, from similar students taking the sequential mathematics course progression, as determined by the Technical College System of Georgia?

RQ2: Does age, race, gender, income, and the type of remedial enrollment model serve as predictors of degree attainment among students enrolled in the accelerated remedial mathematics course and students taking the gatekeeper mathematics course as determined by the Technical College System of Georgia?

The technical college students enrolled in developmental mathematics coursework and the learning impact of these courses in the gatekeeper mathematics course were examined in the study. The researcher also investigated if accelerated mathematics courses shorten the time taken to complete remedial coursework as well as reduce the time taken by the student to achieve a credential. Additionally, the researcher identified students who were more likely to obtain an associate degree based on specific predictors related to race, age, gender, and income.

The conceptual framework of this study is based on the Academic Integration of Tinto's Interactionalist Theory. The study gauged student achievement in remedial mathematics courses and college-level mathematics courses as well as the time taken to acquire the associate degree. Student groups were classified based on the remedial coursework model a student registered in to master the foundational skills in algebra.

Setting and Participants

The total enrollment for the technical colleges of Georgia was 152,934 students in AY 2012 and 148,304 students in AY 2013. Out of all the students referred to remedial coursework between AY 2012 and AY 2013, an average of 68% of these students took remedial mathematics courses while 32% of these students enrolled in remedial English and reading courses. In AY 2012 and AY 2013, half of the students were 25 years or younger and were of minority ethnicity. In AY 2012 and AY 2013, 37% students were male while 63% students were female, and 47% students received the Pell Grant while the remaining students received other form of financial aid (TCSG, 2016).

Table 2

Technical College System of Georgia's Course Structure in Mathematics for Associate Degree

	Course Objectives	Description
MATH I (MATH 0096)	Teach basic arithmetic skills	Remedial course four levels below the gatekeeper course
MATH II (MATH 0097)	Emphasize in-depth arithmetic proficiencies	Remedial course three levels below the gatekeeper course
Elementary Algebra (MATH 0098)	Introduce fundamental algebraic concepts	Remedial course two levels below the gatekeeper course and is considered in this study as a traditional course in the Sequential Model
Intermediate Algebra (MATH 0099)	Impart intermediate algebraic competencies	Remedial course one level below the gatekeeper course and is considered in this study as a traditional course in the Sequential Model
Learning Support Mathematics (MATH 0090)	Teach comprehensive competencies in arithmetic and algebra	Remedial course one level below the gatekeeper course and is considered in this study as the course in the Accelerated Model
College Algebra (MATH 1111)	Teach problem-solving through algebraic concepts	Credit level mathematics course for associate degree and is considered in this study as the gatekeeper mathematics course

The researcher examined achievement rates of students pursuing an associate degree at any technical college in Georgia. The population consisted of students enrolled in the gatekeeper mathematics course, College Algebra designated as MATH 1111, between AY 2012 and AY 2013. The total number of students considered in this study was approximately 30,000. The students also had to successfully pass remedial mathematics courses at college by taking a sequence of MATH 0098 and MATH 0099 courses or the redesigned modular course of MATH 0090. The students enrolled in remedial mathematics courses were placed in the course through the established cut-off scores in the standardized COMPASS test. This is a standardized test used by various postsecondary institutions for student placement in college courses. The cut-off scores for this test were pre-determined by the technical system and all the technical colleges enforce the same scores to place the student in a particular remedial course. Each college could decide the cut-off scores as long as the score was higher than the score set by the state.

The remedial math students were placed in two mutually exclusive groups - students enrolled in an accelerated modular mathematics course labeled as MATH 0090 or students enrolled in a traditional mathematics sequence formed by MATH 0098 and MATH 0099. The content in MATH 0090 was comprised of the competencies in all remedial levels of mathematics, while the objectives in MATH 0098 and MATH 0099 included explicit and compartmentalized pre- and intermediate-algebraic concepts respectively.

A student enrolled in MATH 0090 course took the diagnostic test and completed only the modules deemed as not-mastered based on the diagnostic score, while a student

enrolled in MATH 0098 and MATH 0099 sequence had to complete all the competencies included in both courses. A student required to complete only a few modules in MATH 0090 may be able to complete the course in one semester, whereas a student enrolled in the MATH 0098 and MATH 0099 took at least two semesters to complete the mentioned course sequence. Based on the course structure and delivery of the sequential or accelerated remedial mathematics courses, the two groups were separated beforehand and students were categorized in each of the groups accordingly. All students enrolled in MATH 1111 while pursuing an associate degree at any technical school in Georgia were purposefully sampled as the selection of participants in this study was based on the remedial mathematics course delivery and structure.

Any student enrolled in an associate degree had to successfully pass the MATH 1111 course or other degree level mathematics courses. A student could take other advanced level mathematics courses in lieu of MATH 1111, but since majority of the students enrolled in this course due to guaranteed transferability to other colleges and universities, only the students registered for MATH 1111 were considered in this study. Successful achievement of MATH 1111 was accounted for when a student passed this course with a course grade of C or better. All students enrolled in MATH 1111 between AY 2012 and AY 2013 were selected for this study.

The Technical College System of Georgia transitioned from quarter system to semester system after fiscal year 2011. The summer transition quarter for year 2011, which was for the duration of 5 weeks, was included in the academic year 2012 so only this academic year consisted of an additional term. Typically, all academic years consist of fall, spring, and summer semesters.

Sequential Coursework in Mathematics

Each course in the traditional mathematics sequence was for three credit hours with students meeting for a total of 150 minutes per week. The course delivery for face-to-face class was in a traditional classroom setting and was lecture based. The student was responsible for buying the textbook and MyMathLab software used for supplemental instruction.

A student enrolled in an associate degree and deemed as needing all the courses in the mathematics sequence, based on the placement COMPASS test, took more than a year to complete all the remedial courses. A student, who did not achieve a course grade of S for satisfactory progress or C or better grade in the remedial mathematics courses, ended up retaking the course and spent a longer time in the remedial program to complete the pre-requisites of the gatekeeper mathematics course. Some colleges even administered the COMPASS test as the exit test, after MATH 0099 course completion. A student may successfully end up with an average of C or better in the MATH 0099 course, but had to repeat the course if the cut-off score for the exit test was not achieved. Many remedial courses had to be offered as students had to repeatedly take the same course again and again. Improving the success of remedial coursework was important to the technical colleges so that they do not have to offer multiple sections for students who previously did not pass the same class and it was important for students also to advance academically. The student achievement in remedial courses translated into cost savings to both colleges and students.

Accelerated Coursework in Mathematics

The time taken to complete the remedial coursework and the low achievement rates in mathematics prompted the stakeholders in the technical colleges to redesign the mathematics curriculum for students to master the competencies in a shortened time and academically advance at a faster rate. The entire developmental mathematics sequence was compressed in the redesigned course MATH 0090. This course used modular approach to deliver comprehensive competencies in arithmetic and algebra. The students could master the objectives at their own pace and could potentially complete the entire developmental mathematics sequence in one semester. The students were expected to learn the course content in class by reading materials, watching videos, and working on the problems independently. The redesigned course used technology for subject learning while the instructors assisted the students as required and addressed their individual needs. The instructors were provided with professional development to learn the teaching approaches required to teach the redesigned coursework. The first six modules in the MATH 0090 course contained objectives covered in MATH 0096 and MATH 0097, whereas the remaining modules encompassed algebraic competencies covered in MATH 0098 and MATH 0099 courses.

The redesigned course was more individualized and incorporated the aspects of computer-based learning theory. The classroom was structured so that the students could get help from the instructor, although the instructor mainly functioned as a facilitator. Of the many available computer resources for developmental mathematics from various textbook publishers and technology vendors, MyMathLab (www.mymathlab.com) and Assessment and Learning in Knowledge Spaces, known as ALEKS, (www.aleks.com)

were used by the technical colleges in Georgia. The MyMathlab application is from Pearson, a renowned publisher of several mathematics textbooks. The application incorporates the online version of the textbook and could be customized as per individual requirements. The learning materials included multiple learning aids such as video lectures, animations, and multimedia text; interactive practice problems; concepts broken into simplified objectives; Personalized Study Plan after a student completed an assessment; Assessment Manager for additional media resources; ample questions for quizzes and tests; gradebook with automatic student performance tracking; and MathXL Custom Question Builder for faculty to design assignments. The ALEKS application was collaboratively designed by software experts, mathematicians, and cognitive scientists through the multi-million-dollar grant received from the National Science Foundation at New York University and the University of California at Irvine. The ALEKS application also contained multiple learning tools as MyMathLab, although the application imparts focused instruction on the concepts deemed as necessary as determined by the assessment. Faculty could choose specific content areas for student learning and mastery.

Majority of the technical colleges used MyMathLab for the redesigned courses. The publisher Pearson's technology department worked closely with the faculty to classify the course objectives in the redesigned course into 15 specific modules. Each student took a diagnostic exam for all the modules and dependent on the cut-off score determined by the college either skipped the module or learned the competencies within the module. If the student did not pass the end-of-module exam with the required module cut-off score then the student repeated the module till the score was achieved.

Course Structure

The course standards for each course were decided by TCSG and each college was responsible for teaching the objectives and competencies included in the course. All the mathematics courses were offered for three semester hours. In the traditional face-to-face classes students met for 150 minutes per week in a classroom setting, where content was taught through a lecture. The students either met once a week for 150 minutes, twice a week for 75 minutes, or thrice a week for 50 minutes. The students bought either the physical textbook or eBook with the MyMathLab software, but the software was used for supplemental instruction only. Some colleges also had assigned faculty and peer tutors for additional support.

The colleges had complete autonomy in implementing the LS redesign, although colleges were mandated to implement the redesigned structure in at least one of the three disciplines by Fall 2012. Some colleges stopped offering the sequential courses once the accelerated redesigned course was offered, while some colleges offered both sequential and accelerated courses simultaneously. Some colleges also offered co-requisite enrollment of remedial and gatekeeper courses, but for the purpose of this study only sequential and accelerated models of delivery were considered.

In the accelerated face-to-face course, students were also in class for 150 minutes, where they practiced the mathematics problems on the computer as lectures were not a part of the course delivery. The majority of the colleges used MyMathLab with the exception of one college, which used ALEKS software. For the purpose of this study all technical schools utilizing either software was included in the final analysis. Some colleges had tutoring labs that students could visit for additional reinforcement. The

course instructors facilitated the classroom sessions. Students had to pass each module by scoring the minimum cut-off score designated by the college. The student could repeat the module or move on to the next module as determined by the score achieved in the module. The software provided immediate feedback to the student.

The MyMathLab software incorporated various learning aids to teach the subject matter content. The students could view the video lectures, access the PowerPoints to learn the steps involved in solving the problem, or could view animations. The students could also click a button that prompted and guided them to critically think in order to advance to the next step. The students could also email the instructor for additional guidance on specific questions. Faculty monitored the student progress through the online gradebook and provided feedback as required. The ALEKS software also utilized various learning tools to impart instruction.

The conceptual learning in mathematics can be structured as building blocks where new conceptual knowledge was built on previously learned competencies. The critical thinking and problem-solving components of the subject area followed the principles of cognitive learning theory. The advanced competencies included in the gatekeeper mathematics course are based on the foundational concepts learned in the remedial mathematics courses. The student was actively responsible in mastering the learning objectives by step-by-step problem solving, which required understanding the general rules of algebraic operations and applying these rules to specific cases of advanced algebra.

Data Collection

The study utilized archived data for all technical students in the state of Georgia who were pursuing an associate degree in a technical college and were enrolled in the gatekeeper mathematics course, College Algebra, in AY 2012 and AY 2013. The researcher requested the TCSG to share the relevant student data for this study. The placement scores in the COMPASS test, student enrollment in the remedial course, and student end-of-course grade in the gatekeeper course were extracted from TCSG's student information system. The student data were stored in specially designated fields in the technical colleges' Banner Student Information system. The course grade of the gatekeeper course was designated as A, B, C, D, F, I, IP, or W levels, although a student had to earn a course grade of C or better to be noted as being successful in the gatekeeper course. Each of the students' graduation data or associate degree attainment information was gathered to measure the on time completion rates. The student data for race, age, gender, and income was also collected from the Banner system, where this information is populated based on student input in the Free Application for Financial Student Aid (FAFSA) form.

The data included in this study were collected from educational records and did not contain any personal information that could be identifiable to any individual so the research was not subjective to Valdosta State University's Institutional Review Board oversight. A request was submitted to the institution to grant permission for this study and the pertinent approval can be noted in Appendix A.

Variables

Outcome Variables

The first research question gathered and analyzed information about the outcome variables such as Gatekeeper Success, Semester Count, and Degree Attainment.

Gatekeeper Success. The dependent variable of gatekeeper course success was dichotomous and the student was classified as passing or failing. A course grade of C or better was denoted as pass while all other grades were denoted as fail. For the purpose of this study, the grades relative to incomplete work or course withdrawals were not considered in the data.

Semester Count. The number of semesters taken to complete the associate degree was measured as another dependent variable and was continuous. The actual number of semesters that each of the students took to meet the graduation requirements were collected.

Degree Attainment. The dependent variable for student achievement of associate degree was examined. The student achievement of associate degree was referred as attained if the student received the degree and not attained if the student did not receive the degree.

Predictors

The second research question focused on significant variables and integrated them in the regression model. The variables that were taken into consideration were Gatekeeper Success, Degree Attainment, Remedial Model, Age, Race, Gender, and Income. The regression model was analyzed to obtain information on predictable student characteristics that played an important role in associate degree acquirement.

Gatekeeper Success. The gatekeeper course success was incorporated as a predictive variable in the regression model.

Degree Attainment. The attainment of associate degree was included as the dependent variable in the regression model.

Remedial Model. The independent variable depicted by the student enrollment in either of the remedial course delivery model. The MATH 0090 course was represented as accelerated and the combination of MATH 0098 and MATH 0099 was represented as sequential. The participants in this study were categorized into two exclusive groups for remedial coursework; accelerated or sequential. The students categorized in either the accelerated or sequential groups were independent of each other. In other words, all the students could be placed only in one of the two groups and no student could exist in more than one group at any time.

Age. The students were divided into two groups based on their age. The students were categorized as non-traditional when the recorded age was 25 years or more and were labeled as traditional when the recorded age was below 25 years.

Race. The students were divided into two groups based on their race. The student were labeled as minority if the race of a student is Non-White and were categorized as non-minority if the race of the student is White. The student races of Black, Hispanic, Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, Two or more races, and Unknown all comprised the minority classification.

Gender. The gender of each student was designated as male or female.

Income. The student income field was based on a student receiving the Pell Grant. A student receiving the Pell Grant was catalogued as received Pell and a student that did not receive the Pell Grant was labeled as did not receive Pell.

The data coding utilized for all variables in this study is described in Table 3. Microsoft Excel was utilized to code pertinent data. The data analysis was done through SPSS software.

Table 3

Summary of Data Coding

Characteristic	Code	Data Level
Gatekeeper Success	0 = Fail 1 = Pass	Dichotomous
Semester Count	Actual number of semesters	Interval
Degree Attainment	0 = Not Attained 1 = Attained	Dichotomous
Remedial Model	0 = Sequential 1 = Accelerated	Dichotomous
Age	0 = Non-traditional 1 = Traditional	Dichotomous
Race	0 = Minority 1 = Non-minority	Dichotomous
Gender	0 = Male 1 = Female	Dichotomous
Income	0 = Received Pell 1 = Did Not Receive Pell	Dichotomous

Data Analysis

The purpose of the study was to identify if students enrolled in the sequential or accelerated remedial courses succeeded at similar rates in the gatekeeper course. The

study also examined if students enrolled in the two mutually exclusive groups completed the graduation requirements within normal time frame or not. All student information for age, race, gender, and income determined by Pell Grant receipt were gathered for the entire sample.

The first question investigated the student achievement in the gatekeeper mathematics course, defined by variable Gatekeeper Success, for remedial students who registered for either the traditional mathematics sequence or the redesigned accelerated mathematics courses. The students were taught similar algebraic concepts in the developmental coursework irrespective of the differences in the course delivery between the two models. No matter what platform was used to deliver the teaching, all students enrolled in the gatekeeper mathematics course after successful completion of developmental coursework, should have mastered the required algebraic concepts and should be well-prepared to succeed in the gatekeeper mathematics course. Whether all the students grasped the concepts at the same level and used the learnings in the advanced mathematics course was checked in this question. The sequential mathematics courses enabled students to learn the objectives as a group through a lecture whereas; the accelerated mathematics course model incorporated self-paced learning and advancement via technology. The pass rate of both the student groups was explored in the first question. A chi-square test for independence was used to answer this question.

The researcher also determined the total number of semesters taken by the students to complete the graduation requirements and is defined as the variable Semester Count. All students considered in this study were enrolled in a gatekeeper mathematics course between AY 2012 and AY 2013 to pursue an associate degree and should have

graduated by now. The total number of students who actually attained a degree in 100% of normal time, which is 2 years to achieve an associate degree, was computed. The students were classified as completing the credential in 150% of normal time or 3 years, 200% of normal time or 4 years, or students who have not yet graduated. Both groups of students were also compared to identify the impact of accelerated remedial coursework delivery on credential achievement. The goal of the redesigned mathematics course was to reduce the time taken to complete remedial coursework and in turn enable the student to achieve the degree in normal time. An assessment was made to learn if the accelerated model affected overall retention and student achievement of the associate degree in normal time. The analysis of data obtained through an independent samples *t* test provided an understanding of the success or lack of success in student persistence and eventual degree attainment.

The second question identified if certain student characteristics play a pivotal role in student success at the college, defined by the variables Remedial Model, Gatekeeper Success, Age, Race, Gender, and Income. Traits of the students enrolled in either of the remedial coursework model who attained the associate degree at a higher rate gave knowledge about the factors that enable student success. A logistic regression was used to gain information about the predictive factors and if the explicit characteristics were better predictors of students obtaining the associate degree.

Descriptive Statistics

Descriptive statistics were computed for each of the variables to get an idea about the specific descriptions of the participants. Student success rates in the gatekeeper mathematics course and overall achievement rates were computed for both groups. The

success rate was derived by adding the total number of students who passed the gatekeeper mathematics course with an end-of-course grade of C or better and dividing by the total number of students enrolled in the course. The overall achievement rate was calculated by adding the total number of students that graduated on time and dividing by the total students considered in the population.

Any association between the content learned through either of the remedial models, which may potentially affect the academic performance in the gatekeeper course was checked by the chi-square test for independence. The variables relative to enrollment in remedial courses and achievement in gatekeeper mathematics course were measured at independent and categorical levels so this test was able to examine the relationship between the variables.

The number of semesters taken to graduate was measured on a continuous scale and the independent variable for remedial coursework was dichotomous. The independent *t* test compared the means between the two groups of students. Whether the dependent variable was normally distributed or not, for each of the group of independent variable, was checked and appropriate measures were taken if the data did not meet this requirement. Lavene's test for homogeneity for variance was also determined. Upon successful consideration of all these assumptions, which are relevant to independent samples *t* test, any difference existing in the time taken to complete the graduation requirements by students who took either remedial coursework model was gauged.

Regression Analysis

Liong and Foo (2013) confirmed that data analysis for categorical outcome variables can prominently be done by linear discriminant analysis and logistic regression

multivariate statistical methods. Logistic regression can be utilized to classify many predictor variables without the constraint of multivariate normality and similar variance-covariance matrices in the groups, which makes this method more robust. According to Mertler and Vanatta (2013), logistic regression enumerated entities into groups and combined various independent variables that can help with group predictability when the dependent variable was categorical. A logistic regression predicted positive probability values that fell between 0-1. Some of the advantages of using logistic regression instead of discriminant analysis and multiple regressions were the lack of restrictions with respect to the predictors being distributed normally, related linearly, or variances equality in the groups. Also, in logistic regression, the predictor variables can either be continuous, discrete, or dichotomous. The logistic regression was associated with the possibility of an event and the chances or lack of chances of an event. A probability was the ratio of the number of specific results to the total count of all possible results. In a logistic regression model, the ratio of the possibility of an occurrence to the possibility of a non-occurrence is depicted as odds (p. 295). Therefore,

$$\text{Odds} = \left[\frac{p(X)}{1-p(X)}\right]$$

where:

$p(X)$ = possibility of an occurrence of event X and

$1 - p(X)$ = possibility of a non-occurrence of event X

A binary logistic regression comprised of the combination of significant variables such as age, race, gender, income, and remedial coursework model enrollment was explored to predict the probability of characteristics of students more likely to graduate with an associate degree. The probability of on time graduation outcomes for each of the

student was predicted by this logistic regression model. In short, logistic regression analysis determined a regression equation that precisely predicted the possibility whether the student will achieve the credential or not.

For this study, the odds ratio for the remedial coursework enrollment were computed to evaluate the likelihood of the sequential or accelerated group to succeed in the gatekeeper mathematics course and in degree attainment. The regression equation for this study that encompassed the odds was

$$ln\left[\frac{Y}{1-Y}\right] = B_0 + B_1*\text{Remedial Model} + B_2*\text{Age} + B_3*\text{Race} + B_4*\text{Gender} +$$

$$B_5*\text{Income} + B_6*\text{Gatekeeper Success} + B_7*\text{Semester Count}$$

where:

Y = possibility of an outcome occurrence dependent on the best linear association of the predictor variables

ln = natural logarithm of the odds

B_i = constant value of the coefficients

Model Assessment

The resultant regression model was measured by chi-square goodness-of-fit test. The test compared the real values of the dependent variable with the predicted values of the dependent variable and this helped in identifying the significant variables that were prominently responsible for predicting the dependent variable. The overall model fit was evaluated through -2 Log likelihood to check if data fit the model or not. The Cox and Snell R Square and Nagelkerke R Square, estimation values of R2 signifying the dependent variable's variability by the predictive variable within the equation, was also examined for the final model fit. The classification table for the dependent variable

compared the predictive values of the dependent variable with the actual obtained values as per the logistic regression model. The probability for specific cases was computed to generate the predicted values and was categorized into either of the groups dependent on the probability. Finally, the table of coefficient for variables was used to record the regression coefficient for every variable in the equation. Wald statistic with related significant value tested the levels of significance of the predictors. The values of the odds ratios was checked for measuring the effect size of the variables in the equation to define the association between the variables (Mertler & Vanatta, 2013, p. 295).

Assumptions and Limitations of Logistic Regression Model

Large parameter estimates and standard errors were assessed to check if the data contained enough predictor variables or not. Categories of the discrete variable were combined, deleted, or the number of cases was increased. The expected frequency of data was examined to confirm if the value was larger than 1 and if 20% or less of data had frequency smaller than 5. Appropriate adjustments were made by combining the categories or deleting the number of cases, dependent on the expected frequency of data. The correlation factor between the predictor variable was analyzed and if warranted, one or more of the confounding variable was eliminated from the model to avoid multicollinearity relationships. Standardized residuals were investigated to identify the outliers and cases with values larger than |3| were deleted from the sample to get rid of model ill fit (Mertler & Vanatta, 2013, p. 297).

The results predicted by the regression model were analyzed and presented so TCSG administration can determine if the redesigned mathematics courses are making a

difference in student achievement with respect to gatekeeper mathematics course success and real time taken to attain the associate degree.

Summary

This chapter illustrated the methodology and data analysis that was applied to evaluate if there are any academic differences among technical students of Georgia with respect to the remedial coursework enrollment in either the accelerated mathematics course or the sequential mathematics course progression. The chapter also represented the problem, research design, research questions, sample population, data collection, and data analysis that will be used in the study. The study findings for the two research questions considered in this study will be addressed in Chapter 4, through the data presentation depicted in this chapter. The results will be summarized and discussed in detail, along with findings, conclusions, and further applicative implications in Chapter 5.

Chapter IV

RESULTS

The results of this study conducted to measure the impact of Technical College System of Georgia's redesigned developmental coursework on gatekeeper course success and associate degree attainment are presented in this chapter. First, the enrollment patterns in the sequential and accelerated coursework models are depicted. The success rates of these student groups in the gatekeeper mathematics course are also examined. Second, data analysis of the two groups of students with respect to degree achievement and total number of semesters taken to attain the degree are presented. Third, student groups are classified by demographics to understand the likelihood of student characteristics that are influential in successful academic progression. Finally, analysis evaluating remedial enrollment and the significance of remedial coursework in degree attainment is presented.

Problem Statement and Research Questions

Low retention and graduation rates in the technical colleges in Georgia, especially among students taking developmental courses enabled an interest for this study. The technical system restructured their remedial coursework but lack important performance data regarding the impact of redesigned coursework on retention and completion, when similar students either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by Technical College System of Georgia. The technical colleges also lack performance data that measured student learning

outcomes in the required gatekeeper mathematics course and the number of semesters taken to attain an associate degree. This lack of data on the impact of the redesigned coursework on retention and completion and the lack of performance data on the gatekeeper mathematics course were two of the issues addressed through the completion of this dissertation research.

The following research questions were investigated in this study:

RQ1: Is there a significant difference in the pass rate of gatekeeper mathematics course for students enrolled to earn an associate degree taking the accelerated remedial mathematics course, from similar students taking the sequential mathematics course progression, as determined by the Technical College System of Georgia?

RQ2: Does age, race, gender, income, and the type of remedial enrollment model serve as predictors of degree attainment among students enrolled in accelerated remedial mathematics course and students taking the gatekeeper mathematics course as determined by the Technical College System of Georgia?

Site and Participant Selection

The initial cohort in this study consisted of all students enrolled in a technical college in the state of Georgia. All these students were pursuing an associate degree and had registered for the gatekeeper mathematics course, MATH 1111, between AY 2012 and AY 2013. The Banner Student Information System stores enrollment, demographic, and achievement data for all technical students. Information on success in the gatekeeper mathematics course, associate degree attainment status, number of semesters taken to graduate, age, race, gender, and income was gathered for each student. All students were categorized by enrollment in the remedial sequential or accelerated coursework model.

Approximately 62% of the total students did not take any developmental course in mathematics, so a separate group of non-remedial students was inadvertently created. Thus, all students could be classified into mutually exclusive groups of sequential, accelerated, or neither sequential nor accelerated groups, based on remedial coursework enrollment. For the purpose of this study, only students enrolled in either of the remedial coursework models were observed for achievement patterns. All the students were placed in a remedial course dependent upon the scores obtained on the placement exam. The students chose the remedial coursework model to enroll in and selected a particular model based on their personal preferences.

Data Details

A request was made to the Technical College System of Georgia to provide student data with respect to course enrollment and achievement along with demographic data specific to age, race, gender, and income. All the students were registered for the gatekeeper mathematics course, College Algebra – MATH 1111, between AY 2012 and AY 2013 at a technical college in the state of Georgia. This course was one of the mandatory requirements for an associate degree. The system office provided a raw file with the requested data. All the variables were classified utilizing Microsoft Excel. The variables were coded as per the definitions included in Table 3. The coded data were transferred to International Business Machine (IBM) Corporation's SPSS Statistical software. The software package's version 23 was used for data analysis.

The entire dataset of students who took the gatekeeper mathematics course was filtered so only the students who enrolled in either of the remedial coursework models were examined. The initial cohort contained 28,975 students registered in the gatekeeper

mathematics course; however, only 10,966 of these students were enrolled in either of the remedial coursework models. Some students graduated with multiple credentials so the first associate degree obtained by these students was considered in this study. The students who achieved two or more credentials accumulated a large number of credit hours during their course of study so these hours were also pulled to gauge the total time the student spent at the technical college. Two hundred and thirty-nine student records did not have any semester hours in the Banner Student Information System associated with the major the student graduated with. Even though these records were included in the total graduate count, the semester hours were coded as null. All associate degrees were achieved by the initial cohort before the end of Spring 2016 term. Four hundred and twenty-one students achieved more than one associate degree. Twenty-two students had attained more than two associate degrees.

Student data indicated some students attained the associate degree with a small number of semesters relative to completion. However, these students had a long academic history with the technical college, had attained another credential, or taken core classes while enrolled with a different major code. Technical students often changed their major of study and it was not uncommon for some students to have enrolled in multiple majors during the course of their studies. Due to all these factors, a separate dependent variable summarizing the total number of semesters at the technical college was also considered.

Data discrepancy was noticeable amongst students enrolled in the remedial coursework. Typically, a student who passed MATH 0098, took MATH 0099, and then registered for MATH 1111. Any student who took MATH 0098, did not enroll in MATH 0099, but still registered for MATH 1111 was counted in the sequential model group.

Two hundred and seventy-three students took MATH 0098 or MATH 0099, later on switched to MATH 0090, and then registered for MATH 1111. These students were considered in the accelerated remedial coursework model. All course grades of D, F, W, I, and IP in the gatekeeper course were included in the fail category as the student was not deemed to be successful in this course with such a grade. A student was categorized as being 25 years old or more with respect to year 2013. A student who received the Pell Grant in one or more terms was encompassed in the received Pell group.

Statistical Analytics

The students in the sequential and accelerated remedial models were compared to explain the differences in academic performance with respect to success in gatekeeper mathematics course and degree attainment. All statistical tests measured in the study are described in detail in this area.

Chi-Square Test

The chi-square test was beneficial in examining if there were any differences between the actual and probable values occurring within the groups (Cronk, 2012, p. 45). Pearson's chi-square test was administered to determine if there was any association between the two groups of students enrolled in remedial coursework. The first question investigated how the students enrolled in either of the remedial coursework models performed in the gatekeeper mathematics course. A student learned similar foundational algebraic concepts in developmental coursework, irrespective of the remedial model chosen for enrollment. All students had to successfully complete the remedial course by learning requisite competencies, before they could enroll in the gatekeeper mathematics course. The remedial course equipped students with a strong foundation of algebraic

competencies to succeed in the gatekeeper mathematics course. The chi-square test for independence was conducted for the dependent variable labeled as gatekeeper success and the independent variable labeled as remedial model, to explore if there was a difference in the pass rate for gatekeeper mathematics course between the two groups. Both these variables were categorical and each student could only fall in one of the two independent groups.

Independent Samples t test

The independent samples *t* test measured the means of two mutually exclusive groups when the dependent variable was continuous and the independent variable was binary (Cronk, 2012, p. 62). This test was administered to determine if there was a difference in the number of total semesters taken to graduate with an associate degree by the technical students with respect to remedial coursework enrollment. The test was run for the independent variable, remedial model enrollment, consisting of two non-related categorical groups.

The dependent variable, total number of semesters taken to attain an associate degree, was measured at a continuous scale. The semester count was generated by taking into account the total number of semesters that a student registered to finish the degree program, irrespective of the calendar year for registration. For example, if a student registered for 2 terms, skipped 1 or more terms, came back to the college, and completed the program of study in 3-6 terms; then the student is categorized in the 1-6 semesters group. Students in this study took 1-15 semesters to complete the associate degree, except one student who took 23 semesters to complete the program of study. The value for this record was not transformed as it was the actual time taken by this student to graduate.

The independent samples *t* test was run for the number of semesters taken to complete an associate degree. The semester hours for degree completion were normally distributed for all the students. The Lavene's statistic was 0.60 with a *p* value of 0.807, which stated that variances were equivalent between the sequential and accelerated groups.

Binary Logistic Regression

A logistic regression was a standard statistical model for analyzing dichotomous outcomes. The results of two groups were measured by the association between them, especially when several independent variables were considered (Spicer, 2005, p. 127). The odds ratio quantified the ratio of the probability for an outcome to occur relative to the probability of non-occurrence associated with a single or multiple predictors. The value of odds ratio gave an idea about the projected odds in both the groups and if the differences between the groups were small, equal, or large (Wiest, Lee, & Carlin, 2015).

A binary logistic regression model was created for a total of 10,966 students who were enrolled in either of the remedial coursework models. The regression model combined multiple independent variables to predict the likelihood of occurrence for a categorical dependent variable. In this study, a binary logistic regression was run for the dependent variable, associate degree attainment. Independent variables such as gatekeeper success, remedial model, age, race, gender, and income collectively formulated a regression equation to give an idea about student characteristics instrumental for degree attainment. The dependent variable and all the independent variables were measured on a dichotomous scale. All the students considered in this study were grouped in mutually exclusive categories for each of the variables.

The seven variables were: (1) degree attainment, which was whether the student achieved an associate degree at a technical college: "attained" or "not attained" ; (2) gatekeeper success, which was whether the student successfully completed college level course in mathematics: "fail" or "pass"; (3) remedial model, which was the remedial coursework model that a student enrolled in: "accelerated" or "sequential"; (4) age, which was the student's age in year 2013: "non-traditional – 25 years or more" or "traditional – less than 25 years"; (5) race, which was the student's ethnicity: "minority – not White" or "non-minority – White"; (6) gender, which was the student's gender: "female" or "male"; and (7) income, which was the student's socio-economic status as per the receipt of Pell Grant: "did not receive Pell" or "received Pell". The binary logistic model was created and analyzed utilizing SPSS Statistics. The regression model was measured by chi-square goodness-of-fit test to pinpoint the significant variables essential for dependent variable predictability.

Results

The findings for the statistical tests and the logistic regression model are documented here. The descriptive information about the entire population is analyzed and is followed by the results of the chi-square and independent samples *t* test. Thereafter, the outcomes of the binary logistic regression model are scrutinized to give information about the significant variables, which served as predictors in the final regression equation.

The distribution of student demographic and enrollment characteristics by remedial coursework registration for the entire population are summarized in Table 4.

Table 4

Enrollment Data of Initial Cohort by Remedial Coursework Registration

Variable	Total Students		Neither Sequential nor Accelerated		Sequential		Accelerated	
	n	%	n	%	n	%	n	%
Age								
Non-traditional (ages 26-99 years)	14,224	49.1%	6,809	37.8%	7,004	68.0%	411	61.2%
Traditional (ages 18-25 years)	14,751	50.9%	11,200	62.2%	3,290	32.0%	261	38.8%
Race								
Minority	13,233	45.7%	7,910	43.9%	5,019	48.8%	304	45.2%
Non-Minority	15,742	54.3%	10,099	56.1%	5,275	51.2%	368	54.8%
Gender								
Men	10,343	35.7%	7,192	39.9%	2,948	28.6%	203	30.2%
Women	18,632	64.3%	10,817	60.1%	7,346	71.4%	469	69.8%
Low-Income								
Did Not Receive Pell Grant	14,114	48.7%	9,510	52.8%	4,344	42.2%	260	38.7%
Received Pell Grant	14,861	51.3%	8,499	47.2%	5,950	57.8%	412	61.3%
Gatekeeper Success								
Fail	9,447	32.6%	6,293	34.9%	2,938	28.5%	216	32.1%
Pass	19,528	67.4%	11,716	65.1%	7,356	71.5%	456	67.9%
Degree Attainment								
Attained	6,548	22.6%	3,236	18.0%	3,139	30.5%	173	25.7%
Not Attained	22,427	77.4%	14,773	82.0%	7,155	69.5%	499	74.3%
Degree Attainment in Reference to Gatekeeper Success								
Attained	6,548	33.5%	3,236	27.6%	3,139	42.7%	173	37.9%
Semester Count for Degree Completion								
0 Semesters	239	3.6%	114	3.5%	122	3.9%	3	1.7%
1-6 Semesters	5,317	81.2%	2,633	81.4%	2,552	81.3%	132	76.3%
7-9 Semesters	883	13.5%	454	14.0%	394	12.6%	35	20.2%
10-12 Semesters	100	1.5%	33	1.0%	64	2.0%	3	1.7%
More than 12 Semesters	9	0.1%	2	0.1%	7	0.2%	0	0.0%
Semester Count for Total Time at the College								
1-6 Semesters	16,161	55.8%	12,538	69.6%	3,329	32.3%	294	43.8%
7-9 Semesters	6,741	23.3%	3,517	19.5%	3,048	29.6%	176	26.2%
10-12 Semesters	3,631	12.5%	1,292	7.2%	2,226	21.6%	113	16.8%
More than 12 Semesters	2,442	8.4%	662	3.7%	1,691	16.4%	89	13.2%
Total	**28,975**	**100.0%**	**18,009**	**62.2%**	**10,294**	**35.5%**	**672**	**2.3%**

**Note: Column percentages are shown; these treat the total number of students in each category as the denominator for each variable, except for the total number of semesters taken to complete the degree. The percentage in this category is computed off the total number of graduates instead of the total number of students within the noted category. Also, percentage in the category of degree attainment in reference to gatekeeper success is formulated off the students passing the course.*

Approximately, 38% of the total students in this study's initial cohort had registered for remedial courses. Six percent of these remedial students chose the

accelerated model for developmental coursework. Out of all the students, 49.1% were non-traditional students, but the non-traditional composition in the sequential and accelerated model was much higher at 68.0% and 61.2%, respectively. More than half of the total students were White students and similar enrollment trends were observed in both the sequential and accelerated models for this ethnicity. The total enrollment for female students was around 64%, but both the sequential and accelerated models recorded 70% or more for students in this gender. Around 51% of the total students received the Pell grant, indicating lower socio-economic status; however, the sequential and accelerated model was higher at 57.8% and 61.3%, respectively.

The overall success rate in the gatekeeper mathematics course for the initial cohort was 67.4%. However, a higher percentage of students enrolled in the sequential model (71.5%) passed this course than the accelerated model (67.9%). Approximately, 22.6% of the total students in the initial cohort attained an associate degree. The overall achievement rate of students who graduated on time or in less than six semesters, was 18.4%. Note that this value does not include the students who attained a degree but did not have any credit hours associated with the graduating program of study. Students enrolled in the sequential model were more likely to achieve an associate degree (30.5%) in comparison to students enrolled in the accelerated model (25.7%).

Approximately 71% (7,812) of the total students enrolled in remedial coursework succeeded in the gatekeeper mathematics course (Table 4). Out of the total students who passed the gatekeeper mathematics course, 2,938 students were enrolled in the sequential model while 216 students had registered for the accelerated model. The Pearson chi-

square for the independent variables race, gender, and income was larger than 0.05, which indicated that these variables were not significantly different.

The students enrolled in the sequential model passed the gatekeeper mathematics course at 71.5%, while 67.5% enrolled in the accelerated model passed. The Pearson chi-square test of independence determined if there was a statistical relationship between the types of remedial model enrollment and passing the gatekeeper mathematics course. A statistically significant chi-square test statistic was noted ($\chi^2(1) = 3.99$, $p < .05$), indicating that students enrolled in the sequential remedial model were significantly more likely to pass gatekeeper mathematics course (5%) than students enrolled in the accelerated remedial model. In other words, remedial coursework model and performance in the gatekeeper mathematics course were related in the student population. Similar association was also prominent between technical students enrolled in remedial coursework model and associate degree achievement. Thus, students taking sequential developmental courses tended to have a better success rate in the gatekeeper mathematics course and their chances of achieving an associate degree were higher in comparison to students who enrolled in accelerated developmental courses.

A comparative analysis between the two remedial models was executed to check if there was difference in the length of time taken by students to graduate. A total of 3,312 remedial students attained an associate degree at a technical college. Out of the total students who graduated 3,139 students had enrolled in the sequential coursework model, while 173 students had registered in the accelerated coursework model.

Out of the total graduates in each of the remedial models, students enrolled in the sequential model completed the associate degree on time or in 1-6 semesters at 81.3% (n

= 2,552), while students enrolled in the accelerated model completed in the same time period at 76.3% (n = 132). Note these values do not consider the students records where the associated credit hours for the program of study a student graduated with is null. A lower percentage of students who took the sequential model at 12.6% (n = 394) graduated with an associate degree in 7-9 semesters compared to students who took accelerated model at 20.2% (n = 35).

The time taken to complete the associate degree requirements was also analyzed for the remedial students. The *t* test confirmed the students enrolled in the sequential coursework model completed the associate degree in a fewer semesters in comparison to the students enrolled in the accelerated coursework model. The independent samples *t* test computed to compare the mean scores of the accelerated and sequential remedial models found a significant difference between the means of the two groups ($t(3310) = -3.877$, $p < .05$). The mean of the sequential model ($m = 4.12$, $SD = 2.36$) was lower than the mean of accelerated model ($m = 4.83$, $SD = 2.21$). Results of independent samples *t* test indicated students enrolled in the remedial sequential model were more likely to complete the associate degree requirements in a fewer number of semesters than students enrolled in the remedial accelerated model. The students in the sequential coursework model were likely to finish the graduate requirements in 4.12 ± 2.36 semesters compared to students in the accelerated coursework model who may take 4.83 ± 2.21 semesters to finish the graduate requirements.

The results of chi-square goodness-of-fit test for the binary logistic regression model are presented in Table 5. Of the six independent variables considered in the regression analysis, three variables were included in the final model – gatekeeper success

(entered in Step 1), age (entered in Step 2), and gender (entered in Step 3). The three variables noted significance values < .001, denoting that these variables were substantially important in predicting the dependent variable, degree attainment.

Table 5

Summary of Steps in the Logistic Regression Model

Step	chi-square	*df*	Significance	Variable
1	922.49	1	.000	Gatekeeper Success
2	1179.231	2	.000	Age
3	1218.769	3	.000	Gender

The model summary for the logistic regression is depicted in Table 6. The variation in the dependent variable, degree attainment, modeled by examined independent variables was quantified by the Cox and Snell R Square and Nagelkerke R Square (Mertler & Vannata, 2013, p. 299; Spicer, 2005, p. 129). Based on the values of R square obtained in the regression model, 10.5% to 14.9% of the variation in degree attainment was explained by the variables in the model, suggesting that a reasonable proportion of the variability in success was modeled by the six covariates.

Table 6

Model Summary of Logistic Regression

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	12512.392[a]	0.081	0.114
2	12255.651[a]	0.102	0.144
3	12216.113[a]	0.105	0.149

The model-based prediction for the dependent variable, degree attainment is shown in Table 7. The classification table shows the number of individuals predicted to attain a degree by the regression model alongside observed degree attainment in the actual collected data (Mertler & Vannata, 2013, p. 299). The model failed to predict any "successes" using the default predicted probability cut off of .5. However, others have noted that 0.5 may not be the optimal choice (Spicer, 2005, p. 126). A cut value in the classification of dependent variable gave an idea about the probability of a student attaining an associate degree categorized into "attained" or "not attained" category. Decreasing the cut value generated worse prediction for "not attained" category, but improved the prediction for "attained" category. However, the smaller cut value lowered the average of correctly predicting cases for the overall model.

Table 7

Classification of the Dependent Variable

Observed		Predicted		
		Degree Attainment Status		Percentage Correct
		Not Attained	Attained	
Degree Attainment Status	Not Attained	1150	6504	15.0
	Attained	98	3214	97.0
Overall Percentage for Cut Value .100				39.8
Degree Attainment Status	Not Attained	6910	744	90.3
	Attained	2592	720	21.7
Overall Percentage for Cut Value .450				69.6
Degree Attainment Status	Not Attained	7654	0	100.0
	Attained	3312	0	0.0
Overall Percentage for Cut Value .500				69.8

Table 8 reports the coefficients obtained in the final logistic regression equation, which identified the significant variables serving as predictors for attaining an associate degree at the technical college. The initial model considered the independent variables such as gatekeeper success, remedial model, age, race, income, and gender. Results of the regression model suggested that the three variables (gatekeeper success, age, and gender) were statistically significant for the overall model of degree attainment predictability [-2 Log Likelihood = 12216.113, $\chi^2(2) = 1218.769$, $p < .001$]. Wald statistics confirmed the three variables significantly forecasted degree achievement.

Logit (Degree Attainment) = -1.304 - 1.619 * Gatekeeper Success + .158 * Remedial Model + .806 * Age + .019 * Race + .302 * Gender - .020 * Income

The tolerance statistics run for this model showed all the independent variables exceeded the 0.1 value, meaning all the variables were accepted in the model (Mertler &

Vannata, 2013, p. 300). The regression coefficient is -1.304, which indicated how the independent variable affected the dependent variable. *Wald* evaluated the regression coefficient's significance as well as significance of all the variables instrumental to the model. The variables gatekeeper success, age, and gender; included in the model had *p* values < .001, which signified these variables were important in predicting the probability of attaining an associate degree.

The odds ratio for student enrollment in the sequential or accelerated remedial coursework model was examined for the likelihood of attaining an associate degree. The values of odds ratio gauged the effect size of the independent variables in the equation to give an idea about the relationship between the variables (Mertler & Vannata, 2013, p. 298). The odds of a remedial student passing the gatekeeper course in mathematics and attaining an associate degree at a technical college were 0.2 times lower than a remedial student failing the gatekeeper course in mathematics. The odds of traditional students, defined as those 25 years or younger in age, to graduate were 2.2 times higher than they were for non-traditional students, above 25 years of age. The odds of females receiving the associate degree were 1.4 times higher than male students receiving the degree.

Table 8

Logistic Regression Statistics Showing the Predictors for Degree Attainment

Predictor	Coefficient	Wald Statistic	*P*	Odds Ratio
Gatekeeper Success	-1.619	658.521	0.000	0.198
Age	0.806	247.753	0.000	2.238
Gender	0.302	38.943	0.000	1.353
Constant	-1.304	151.463	0.000	0.271

Summary

The researcher investigated the influence of remedial coursework model on student performance for the gatekeeper mathematics course, the total number of semesters taken to graduate with an associate degree, and identified specific attributes instrumental in graduation, when students enrolled in either of the two remedial coursework models. In the first research question, the researcher investigated if there was a difference in the pass rate of the gatekeeper mathematics course for students enrolled in the sequential and accelerated model for remedial coursework at a technical college in Georgia. The students who took sequential courses in mathematics passed at a higher rate than students who took the redesigned accelerated course in mathematics.

The researcher determined in the second research question if specific independent variables such as gatekeeper success, age, race, gender, income, and the type of remedial enrollment model served as predictors of associate degree attainment among students who took remedial courses in mathematics. Results of binary logistic regression indicated enrolling in the remedial coursework model was not statistically significant in the regression model. Thus, irrespective of the student taking sequential or accelerated courses in mathematics, the degree achievement was not affected by which developmental path a student chose. Race and income levels were also not statistically significant and did not play a role in affecting the likelihood of a student graduating with an associate degree or not. The logistic model depicted traditional age of students had the highest impact on associate degree achievement and this variable was followed by the female gender. Taking a gatekeeper mathematics course by students enrolled in

accelerated model was significantly and negatively correlated to receiving an associate degree.

This chapter determined the impact of redesigned course in remedial education at the technical colleges in Georgia. A detailed picture of the participants and their academic success in gatekeeper mathematics course as well as the number of semester taken to achieve an associate degree could be gathered from this chapter. Any specific demographic characteristics of a student that can lead to a successful academic pathway were analyzed in this chapter.

Chapter 5 describes the significance of this study as it pertains to 2-year colleges with respect to student retention and completion, especially in reference to students subjected to remedial education upon entrance to a postsecondary institution.

Chapter V

CONCLUSIONS, INTERPRETATIONS, AND RECOMMENDATIONS

This chapter illustrates the goal of the study, prevalent literature on remedial education, findings pertaining to the research questions, implications of study, practical implications for further research, and conclusions drawn from the study with respect to redesigned coursework in remedial mathematics.

Discussion

Community colleges play a critical role in aiding the state and federal goals of increasing access in higher education, as a high number of students enroll in these institutions due to their affordability. The community colleges faced challenges to increase the graduation rates, without compromising the educational quality. These colleges were also challenged to function on diminishing state budgets as it was not easy to increase tuition in lieu of the decreased funding. In community colleges, one of the major cost imperative areas was the all-encompassing remediation program. Simply redesigning an instructional program did not guarantee successful outcomes if the overall organizational policies were not systematized towards completion. Students referred to remedial education needed to be directly guided towards degree level courses with additional support so they did not sway from the academic pathway (Jenkins & Rodriguez, 2013).

Remedial education is not serving its purpose of providing basic knowledge to students so they can improve their performance in degree level courses and eventually

graduate with a credential. Many states have tried innovative approaches to generate successful learning outcomes for remedial students. Co-requisite remediation was one of the approaches that gained success in the Colorado Community College System, the Georgia Board of Regents, Indiana's Ivy Tech Community College, the Tennessee Board of Regents, and the Community and Technical College System of West Virginia. The remedial students were supported in their learning when they enrolled in degree level courses. The developmental course acted as a co-requisite rather than a pre-requisite (Palmer, 2016).

Pruett and Absher (2015) studied 400,000 students of the 2013 Community College Survey of Student Engagement (CCSSE) cohort where six out of ten students were referred to developmental education. The study used retention as the dependent variable and included independent variables such as student engagement, remedial coursework information, time spent in academic and college activities, number of times students used college provided services for tutoring and advising, students' grade point average (GPA), and educational levels of parents. A logistic regression model was administered to generate an equation that predicted student retention. The study concluded overall GPA and academic engagement were important factors in student retention. Developmental students were at high risk for attrition so colleges administered extensive support services to help these students progress academically. An early alert system identified at-risk students at the onset (Pruett & Absher 2015).

Tinto's dropout model (1993) also stressed a student's prior attributes and experiences played a significant role in how well a student integrated in a college environment. Together the social and academic associations determined the educational

outcomes and affected a student's decision to continue or dropout from a postsecondary institution (Tinto, 1993).

The purpose of this study was to determine if there was a difference in student performance in the gatekeeper mathematics course and the number of semesters taken to complete the graduation requirements, when similar students enrolled in an associate degree program either take the accelerated remedial mathematics course or the sequential mathematics course progression determined by the Technical College System of Georgia. The study was structured around two research questions. The first question investigated if there was a significant difference in the achievement rates of students enrolled in sequential or accelerated coursework for remedial education. The second question examined the variables that served as predictors of degree attainment among both groups of students. Each question is analyzed and recommendations are made to the technical colleges pertinent to the findings.

Overview of Study

The technical system's purpose for redesigning remedial courses was to facilitate students to master explicit modules as per the academic gaps for targeted objectives, identified by the placement test. The technical college system had not investigated the effects of the redesigned remedial courses on retention and degree attainment. The technical colleges had also not examined if choosing a sequential or accelerated model for these courses played a significant role in generating successful outcomes in the gatekeeper mathematics course or completing the associate degree. The researcher analyzed in this study if the concepts learned in the redesigned coursework affected

achievement in the gatekeeper mathematics course and impacted the retention and graduation rates of technical students.

At the technical colleges, a standardized placement test was administered to assess the content knowledge in algebraic concepts. Based on the cut-off scores of the placement exam, a student was referred to one or more levels of developmental courses. The remedial coursework was redesigned to allow students to complete the foundational subjects in a timely manner and quickly enroll in the program courses to enable on time completion. The redesigned courses encompassed competencies that were critical to the occupational courses and any student enrolled in the accelerated model would have been able to complete the remediation requirements in a shorter time span. The reduced time taken would have enabled the students to fulfill the graduation requirements on time.

After the introduction of redesigned course in remedial program, students had a choice of enrolling in sequential or accelerated developmental program. The students chose either of the remedial coursework models dependent on their personal preferences. Upon successful completion of remedial courses, students registered for the degree level coursework.

Methodology

The population of this study consisted of all students registered for the degree level gatekeeper course in mathematics, College Algebra, between AY 2012 and AY 2013. The achievement rate of the remedial students in the gatekeeper mathematics course and associate degree attainment was examined in this study. The end of course grade in this gatekeeper course along with the graduation data were collected for these students. The technical system stores the academic and personal records for all students

across the state in the Banner Student Information System. Pertinent information about age, race, gender, and income was also gathered for all the students.

Logistic regression was apt for this study as the outcomes were binary in nature, meaning students can either pass or fail the gatekeeper course and either attain or not attain an associate degree. In this study, all remedial students were classified as per their enrollment in the sequential or accelerated model. All students' achievement rate in the gatekeeper mathematics course and associate degree attainment was investigated. The regression model was able to predict student characteristics that enable remedial students to graduate.

Summary of Findings

RQ1: Is there a significant difference in the pass rate of gatekeeper mathematics course for students enrolled to earn an associate degree taking the accelerated remedial mathematics course, from similar students taking the sequential mathematics course progression, as determined by the Technical College System of Georgia?

The first question sought to analyze the achievement rate of remedial students enrolled in the gatekeeper mathematics course. Data indicated there was a significant difference in the pass rate of gatekeeper mathematics course for remedial students enrolled to earn an associate degree taking either the sequential or accelerated coursework model. The students in the sequential model recorded a higher success rate (71.5%) in the gatekeeper course than students in the accelerated model (67.9%). The students who did not take any remedial course had the lowest success rate (65.1%) in this course. Students needing limited or no remediation succeeded at a lower rate in degree level mathematics course. The students registered in the sequential model for remedial

coursework studied basic and intermediate algebraic concepts for at least two semesters before learning the advanced algebraic concepts in the gatekeeper mathematics course.

The students who did not require any remediation spent the least amount of time at the technical college; whereas students who spent one or more semesters for developmental education took longer to complete the program of study. The students enrolled in sequential coursework had to complete two levels in mathematics in different semesters, while the students taking the accelerated course could potentially complete the remedial course in a single semester. However, the students in the sequential model were more likely to complete the graduation requirements in fewer semesters than students enrolled in the accelerated model.

RQ2: Does age, race, gender, income, and the type of remedial enrollment model serve as predictors of degree attainment among students enrolled in accelerated remedial mathematics course and students taking the gatekeeper mathematics course as determined by the Technical College System of Georgia?

Through the second research question, the researcher identified specific student attributes that enabled successful completion of an associate degree for all remedial students. The students' demographic information in terms of age, race, gender, and income was gathered along with achievement data. Student enrollment in the remedial coursework model, achievement data for the gatekeeper mathematics course, graduation information, and demographic data were included in the regression model. Of the six independent variables included in the regression model, the three variables pivotal in pinpointing the predictors for successful student outcomes were gatekeeper success, age, and gender.

The enrollment in remedial coursework models, irrespective of the chosen model, was not found to be significant in predicting degree attainment. Race and income were also not important factors for predicting likelihood of a student graduating with an associate degree. Age was the most important variable, followed by gender, to positively impact probability of a student attaining an associate degree. Remedial students passing the gatekeeper course in mathematics was associated with an 80% lower likelihood of achieving an associate degree, in comparison to students failing the gatekeeper course in mathematics. The probability of remedial students graduating with an associate degree was 124.4% higher for traditional students in comparison to non-traditional students. The odds of remedial female students attaining the credential were 35.3% higher than male students. Overall, the odds of a female student who is less than 25 years of age and graduating with an associate degree were more in comparison to other students. The chances decreased if the student had passed the gatekeeper course in mathematics.

The restructuring of remedial coursework at the technical colleges did not generate successful outcomes for all the students enrolled in an associate degree program. The researcher examined the technical students referred to developmental education and identified the student groups that were less likely to attain a credential. Based on the findings of this study, the aftereffects of the remedial reform are discussed in detail in the next section.

Implications of Redesigned Coursework

The goal of accelerated coursework in developmental education was to convey specific competencies in algebra, in which students were deemed to be deficient. These students would have been able to complete remediation faster as only selected modules

were to be mastered. Also, since the remediation needs were limited, an expectation was there for these students to do well in the gatekeeper mathematics course. Data indicated many students enrolled in the redesigned course multiple times, which defeated the rationale for fast-paced remediation.

Academic progression is important and splitting the requisite foundational concepts in multiple levels provided better avenues for student success in the degree-level mathematics course. A student learned certain concepts in the first level course and this course acted as a strong base to build upon in the consecutive level. In the second level, the student practiced prior learned materials and mastered more advanced concepts. This knowledge may be transferred at a better rate in the gatekeeper mathematics course. Essentially, the content reinforcement in consecutive levels of sequential coursework may have helped the student to improve academic performance in the degree level course. Success in sequential coursework may be acting as a motivational factor for academic advancement and helped in retaining the student at college.

The redesigned course provided immediate feedback to students as to how they performed in the assigned homework, quiz, or test. Also, the redesigned course used only technology for teaching the foundational concepts. The faculty acted more as a facilitator while students learned the concepts through multimedia presentations. Only using technology for accelerated remediation did not impart a strong outlet for content mastery and posed hindrances in successful completion of degree level coursework.

Barring the on-line courses, the sequential courses were typically taught in a lecture form by faculty members. The overall success rates of the entire sample were considered in this study, irrespective of the course delivery platform. The results of the

study did not gauge if the success rates in the traditional and on-line platforms varied significantly and if students enrolled in these courses performed differently in the gatekeeper mathematics course, so a separate study should be done to evaluate such differences.

The motive behind the technical system redesigning the remediation curriculum did not generate effective learning outcomes as the technical colleges are currently going back and forth between sequential, modular, and co-requisite approaches. Any student who successfully did not complete a credential resulted in lowering the graduation rates.

The researcher did not follow the remedial students who did not succeed in the degree level mathematics course and did not check if these students dropped out of college for specific reasons or pursued another credential at the technical college which did not require successful completion of the gatekeeper mathematics course. Students from 4-year colleges may be attending technical colleges to fulfill the remediation requirements only and may be transferring back to the home school for continuation with the program of study in which they had originally enrolled. A separate study examining the academic path of students who enrolled in remedial courses but did not complete the gatekeeper course should be conducted and reasons for departure from the original program or college should be investigated. The data obtained from such a study can aid the technical colleges in understanding the causes and addressing the overall factors that hinder students from continuing the program of study.

Citizens understand the importance of higher education and how academic credentials can lead to a lucrative career, which in turn can affect their personal lifestyle. Postsecondary institutions across the nation are vigilantly trying to increase the

educational access and opportunities for minority students. Current national data indicates there is an increase in the number of minority students pursuing a college credential. Researchers have been studying postsecondary students and their achievement rates at-large. Depending upon the focus of research conducted, results of studies may or may not indicate academic success of minority students.

Technical colleges have an academic environment catered to dual enrollment where traditional students can gain credits for core classes. The results of this study did not portray statistical significance of minority students in a specific socio-economic area. Maybe the educational policies and services geared towards enhancing learning outcomes of minority students can provide requisite support for more students to graduate, which is why a difference was not noted in the success rate of these students. Intrinsic motivation and ample support systems within the cultural environment may also be enabling the minority groups to complete the credential. Moreover, availability of financial aid, grants, and scholarships enable the technical students to gain pertinent funding so students are able to continue pursuing the credential instead of dropping out of college for monetary reasons. Any disparities that may occur because of income levels are thus eliminated for these students, which may be why income was not deemed as significant variable in degree attainment. For future research, this study should be replicated to measure student achievement disaggregated by age, race, gender, and income. A separate study surveying the student experiences in the accelerated and sequential models may also be beneficial in identifying the specific avenues of both models pivotal in enhancing students learning and mastering the algebraic concepts.

Limitations

The technical system developed unified curriculum standards for the redesigned coursework in developmental education and gave full autonomy to the colleges in implementing this structure. Although, such flexibility and non-standardization in course offering and delivery does not enable proper evaluation of program success or lack of success. The different versions of redesigned course offering across the system make it extremely difficult to effectively measure the learning outcomes of the redesigned coursework and the time taken to complete the program of study. Two students with the same cut-off score in the placement test could be placed in one remedial course at one college or in a gatekeeper course at another college, thus creating inconsistencies in remedial referrals amongst students with similar abilities. Such discrepancies across the technical system may affect reliable course transferability to 4-year colleges.

Moreover, a student referred to developmental coursework had been identified to have academic gaps that may hinder degree completion. Remedial courses were deemed to teach key concepts and successful completion of these courses may serve as a motivator to do well in degree level coursework. Superior learning experience may not be guaranteed if students had to learn the vital concepts on their own since the instructor acted more as a facilitator instead of a lecturer. Faculty teaching the remedial courses were not organizationally trained to instruct or facilitate the remedial courses in a standardized fashion, so the disparities in the course and content delivery across the board may affect the overall results.

Many times students in postsecondary institutions may be first-generation students and may not have knowledge or support to successfully navigate in a

postsecondary institution. These students may not have a true understanding of the importance of the placement exam and may not be aware of the consequences of not doing well in this exam. A student placed in an unfamiliar environment without being fully prepared to take such an important test may accidently result in that student not achieving high scores and in turn be misplaced in a developmental course. Student placed incorrectly above or below true remediation levels may inadvertently affect the overall retention and completion rates.

During this study just one of the core courses in mathematics required for an associate degree was considered. Other degree level courses such as Mathematical Modeling (MATH 1101) and Quantitative Skills and Reasoning (MATH 1100) were not offered across the system but only by a few technical colleges, which is why the student achievement in these courses was not considered in this study. A separate study should be conducted to measure the student success rates of remedial students enrolled in these gatekeeper courses.

Recommendations

Technical college system need to investigate the reasons for redesigned remedial coursework, which was tailored to fast-track remediation and increase successful learning outcomes in degree level courses so students may complete the degree on time, not functioning as initially intended. Technical colleges need to evaluate why students enrolled in the accelerated course are not mastering the concepts within one semester and were re-registering for the same course in subsequent semesters. The colleges also need to examine why students enrolled in the accelerated coursework model were not succeeding in the gatekeeper mathematics course at a higher rate and took longer to

graduate, than the students enrolled in the sequential coursework model. The technical system can evaluate from this study that the remedial education somewhat negatively affected success in a gatekeeper mathematics course and in associate degree attainment. The researcher noted that students enrolled in the accelerated model were more likely to be retained at the college, at least for the succeeding 2 years. Technical colleges can divert this positive retention to guaranteed graduation by providing proper support and encouragement to these students.

Technical colleges need to identify why non-traditional and male students enrolled in remedial courses were less likely to complete the associate degree requirements. The specific barriers that disabled these students from graduating should be analyzed and explicit educational policies should be put in place to improve the achievement rates of these students. Technical colleges can utilize the values recorded for technical students referred to remedial coursework and their achievement in gatekeeper mathematics course, age, and gender to formulate the regression equation generated by this study and to catalogue a student's probability of attaining an associate degree. Any student deemed as less likely to graduate should be provided with additional resources and guidance to facilitate successful completion.

The technical college system needs to inspect the programs of study offered in its colleges and if these programs have lucrative employment prospects. The system also needs to review the schedules, days, times, and platforms of courses included in various programs. The obtained data can inform the technical colleges if the course and program offerings addressed the needs of non-traditional students in the community. Typically, non-traditional students enrolled in a technical college gain specific skills that enable

them to enhance their personal and professional lives. These students were more likely to depart from the college if the course schedules did not mesh well with the individual obligations they had to take care of or if they did not perceive the program of study to add any value to their lives.

Faculty and staff at colleges across the country are designing innovative approaches to improve the learning outcomes of remedial students. Extensive research has been done to identify factors that can enhance student engagement and thus impact student retention and completion in postsecondary education. There is a dire need to mesh the learnings of remedial education betterment strategies with enhancement of student success avenues as the achievement of remedial students cannot be positively affected without a holistic paradigm.

Postsecondary institutions can learn from the innovative strategies piloted and implemented across the nation in developmental education. Colleges need to understand that just changing the course structure and delivery of a remedial program may not necessarily translate into student success. Time and effort should be put into thoroughly revamping remedial programs and additional requirements should be mandated to support these students. A properly structured remedial program can help such students complete the remediation requirements in a short span and enable on time program completion. An exemplary framework in remedial education needs to have a tight integration of the following components:

- Purposeful Advisement: Faculty and staff advisors at the college should be vigilant about unconscious advisement related errors and strive to guide students to register in defined academic pathways that enable and facilitate on time

completion. If possible, remedial students should be registered as cohorts and efforts should be made to nudge these students for fostering strong peer-to-peer associations. Periodic face-to-face sessions should be conducted to build a relationship between the advisor and advisee.

- Reform Remediation: The remedial course should be offered for five credit hours where three hours should be devoted for conceptual knowledge and the remaining two hours should be utilized for imparting specific skills that can enable academic progression. Structured remedial concepts including only requisite skills to heighten knowledge of key concepts that provide a strong foundation in reading, English, and mathematics can help students in eliminating the academic gaps. These key objectives should be encompassed in a course lasting for the duration of one semester only. Students referred to developmental courses should be encouraged to attend 2-3 hours of tutoring for additional content reinforcement. Normally, pertinent objectives are re-emphasized in core courses so all crucial content related gaps can be addressed as a student advances in degree level courses. Any student who scored 5-10 points below the cut-off score in the placement exam should be allowed to enroll in the gatekeeper course, instead of being referred to remedial coursework.
- Restructure Remedial Mathematics Course: In the 2-year colleges, numerous concepts included in the remedial mathematics course are repeated in the gatekeeper mathematics course so the modular mathematics course should be designed with focused but limited concepts to impart a thorough understanding of preliminary concepts. Faculty should be involved in refining the curriculum

standards of this restructured course. A refined foundational structure in remedial mathematics course defined as per below would enable students to gain comprehensive knowledge of algebraic concepts:

- ❖ Section 1: Review and simplification of whole numbers, fractions, decimals, percentages, ratio, and real numbers excluding word problems (3 weeks)
- ❖ Section 2: Linear Equations (2 weeks)
- ❖ Section 3: Polynomials (2 weeks)
- ❖ Section 4: Rational Expressions (3 weeks)
- ❖ Section 5: Radicals (2 weeks)
- ❖ Section 6: Quadratic Equations (3 weeks)

Students should be encouraged to utilize open resources for education to supplement learning or reinforce various mathematical concepts. Such websites will also lessen the cost incurred by students to buy technological products marketed by a publisher.

- ➢ Support Services: Colleges should promote faculty and staff to provide additional sustainable strategies to enhance the learning experience. Non-traditional students have many personal obligations that may deter them from spending any time outside their class schedule at the college, which in turn would hinder them from taking advantage of college provided services. One hour of the remedial course should be used for academic enhancement and reinforcement by mandated tutoring sessions. These sessions should be conducted by both faculty and peer tutors so students have a choice of re-learning or reinforcing conceptual

knowledge from either tutors. The second hour of remedial course should be used for divulging guidance about systemic intricacies so students can get a holistic understanding of college navigation and academic advancement. Information in areas of study skills, test taking skills, stress management, time organization, financial literacy, and overall motivation towards goal accomplishment should be highlighted in this hour. Colleges need to make students aware of various services students could rely upon to better the learning experience.

- Early Intervention: A system to identify and aid at-risk students on attrition related concerns can play a crucial role in addressing recurring issues that can delay on time completion. Faculty is in constant contact with students and should be able to immediately raise a flag when the student is deemed to be at-risk of completing the course. Upon receiving an alert and as warranted by the situation, support staff can administer proactive processes or interventions to heighten academic as well as non-academic experiences and in turn positively affect retention. College administration should allocate specialized personnel to help the alerted students and provide the necessary support. Moreover, colleges should periodically analyze the outcomes of the alerted students, evaluate the operational methodologies, and accordingly update the functions to improve the teaching and learning experiences at the college. The early alert initiative should be included in the institution's completion agenda.
- Systemic Professional Development: College personnel should be encouraged to create and implement targeted approaches, which are always student focused. Faculty and staff should be provided with ample professional development

opportunities so they can design strategies that would empower students to successfully complete their program of study. Personnel who developed outstanding educational tactics that boosted retention and completion should be appreciated college-wide so others will be encouraged to follow their footsteps in designing innovative processes. Also, selected faculty should be extensively trained to implement successful strategies, thus guaranteeing uniform delivery across the system.

It is not an easy task for educational institutions to integrate the above mentioned constituents. Any strategic planning project required individuals in an institution to unquestionably cooperate and remarkably organize process planning, problem solution, and effective execution (Fogg, 1994, p. 3). Knowledgeable facilitators who understand the challenges and intricacies of developmental education and have outstanding analytical and interpersonal skills could reform changes to generate exceptional successes for students enrolled in remedial coursework.

Conclusions

The technical system in Georgia identified a need to modify the curriculum and delivery of the developmental coursework. The aim and objective for this redesign was to eliminate multiple levels of coursework referred for remediation, but at the same time impart critical skills in which a student is deemed deficient. The findings indicated students enrolled in accelerated coursework did not succeed at a high rate in the gatekeeper course in mathematics nor attained the associate degree on time. The technical system should have implemented the accelerated model at selected locations, analyzed

student success, and scaled this approach in a standardized fashion; only if and when the modular approach generated exceptional and long-term student learning outcomes.

Students enroll in a postsecondary institution with intention to acquire a credential and obtain a lucrative career. Many times students may end up stopping or dropping out of college because of personal hardships or inability to successfully balance educational, personal, and work obligations since they may not have sufficient resources or support to help juggle everything going on in their lives. Lack of associate degree attainment may be a result of multiple factors and not just relative to academic deficiencies. The basic assumption that sequential coursework in remedial education hinders student achievement is a myth, as per this study. Provision of adequate and equitable services to aid these students to successfully manage the challenges encountered along the academic pathway can favorably enhance student retention and completion.

Student success should be an institutional priority. Educational institutions come up with new initiatives very frequently but are not vigilant about measuring the learnings from the administered initiatives. Many times initiatives are merely put in place to satisfy the federal and local agencies but all stakeholders are not held accountable for the success or lack of success of these initiatives. Educational improvement plans can be designed to serve a specific purpose and can successfully strategize the colleges' mission to generate exceptional learning outcomes. An institution has to diligently coordinate efforts by addressing major as well as minor concerns that can affect student learning. Leaders at institutional, state, and federal levels should substantially contribute towards successful reforms. Leaders need to cultivate a significant culture shift to embrace the initiative implementation by involving and encouraging stakeholders in every area of the college.

Educational policies should be instrumentally reformed by faculty and staff who are in direct contact with students and effectively understand the intricate challenges encountered by the students. Many times due to political influences, administration in postsecondary institutions may inadvertently develop a tunnel vision in analyzing an issue from a certain angle rather than focusing on the bigger picture that can impact long-term student retention. Leaders should welcome input from all stakeholders and strategize the positives and negatives of each factor to optimize the institutional resources and functionalities with a sole motive of enhancing student learning outcomes.

Developmental education plays a crucial role in tackling academic under-preparedness of students enrolled in a postsecondary institution. Success in this area is directly proportional to laying a robust academic foundation and inherently motivating a student to be retained at college. Multiple levels of remedial education may result in unintentional creation of multiple exit points for students. Colleges do not have to sway from the mission of remediation to fill the academic gaps of students, but effective reforms influencing this area can nudge students towards fruitful program accomplishment. Colleges and universities should refine remedial educational structure with targeted curriculum integrated with purposeful advisement, sustainable support services, early intervention, and focused guidance from faculty and staff to be highly influential towards student success. Engaging students in developmental studies and core classes; strategically planning and creating a culture and environment conducive to learning; optimally using resources to shape the student learning outcomes; removing potential obstacles along students' academic pathway; and fostering relationships

between the student and the institution can result in boosting the retention and graduation rates in postsecondary education.

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APPENDIX A:

Institutional Review Board Exemption

Institutional Review Board (IRB)
for the Protection of Human Research Participants
IRB Review Form

Project Title: **Regression Analysis of Remedial Mathematics Students' Success in the Technical College System of Georgia**

Name: **Ms. Nimisha Raval**

Faculty Advisor: Dr. Robert (Ronny) Green

Department: **Leadership**

E-mail: nraval@valdosta.edu

Telephone: **478-321-8616**

Please indicate the academic purpose of the proposed research:

☒ Doctoral Dissertation
☐ Master's Thesis
☐ Other:

1. ☐ **YES** ☒ **NO** **Will you utilize *existing identifiable private* information about living individuals?** "Existing" information is data that were previously collected for some other purpose, either by the researcher or, more commonly, by another party. "Identifiable" means that the identities of the individuals can be ascertained by the researcher by name, code number, pattern of answers, or in some other way, regardless of whether or not the researcher needs to know the identities of the individuals for the proposed research project. "Private" information includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place or information provided for specific purposes that the individual can reasonably expect will not be made public (e.g., a medical record or student record).

Note: If you are using data that: (1) are publicly available; (2) were collected from individuals anonymously (i.e., no identifying information was included when the data were first collected); (3) will be de-identified before being given to the researcher, (i.e., the owner of the data will strip identifying information so that the researcher cannot ascertain the identities of individuals); or (4) do not include any private information about the individuals, regardless of whether or not the identities of the individuals can be ascertained, your response to Question 1 should be NO.

2. ☐ **YES** ☒ **NO** **Will you *interact* with individuals to obtain data? "**Interaction" includes communication or interpersonal contact between the researcher and the research participant, such as testing, surveying, interviewing, or conducting a focus group. It does not include observation of public behavior when the researcher does not participate in the activities being observed.

3. ☐ **YES** ☒ **NO** **Will you *intervene* with individuals to obtain data? "**Intervention" includes manipulation of the individual or his/her environment for research purposes, as well as using physical procedures (e.g., measuring body composition, using a medical device, collecting a specimen) to gather data for research purposes.

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆

Your proposed research *is not* subject to Institutional Review Board oversight.

Please contact Tina Wright, Research Compliance Specialist, with additional questions or concerns. We look forward to helping you with future IRB applications.

Elizabeth W. Olphie **08/30/2016**

Elizabeth W. Olphie, IRB Administrator — Date

Thank you for submitting an IRB application.

Please direct questions to irb@valdosta.edu or 229-259-5045.