COLORADO COMMUNITY COLLEGES’ TRANSFER PRODUCTION:
THE EFFECT OF MATH REMEDIATION

by

Patricia A. Erjavec

MNM, Regis University, 2002

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This dissertation for the Doctor of Philosophy degree by Patricia A. Erjavec has been approved for the Department of Leadership, Research, and Foundations by

_____________________________________
Aldo Ramirez, Chair

_____________________________________
Margarita Lopez

_____________________________________
Sylvia Martinez

_____________________________________
Marcus Winters

_____________________________________
Patricia Witkowsky

_____________________________________
Date
Colorado joins a cadre of states implementing a performance based funding model for institutions of higher education-a performance model that primarily champions completion rates and student progression toward a certificate or degree. Appropriately, the Colorado Community College System considers the transfer of its students to a four-year institution an important component of meeting its mission of facilitating the educational success of students. A type II fuzzy regression discontinuity model is applied to a subset of Colorado community students who scored within the neighborhood (bandwidth) of the Accuplacer® Arithmetic Assessment cut score of 85 to determine if the prescribed treatment (remediation) affects the likelihood that community college students will transfer to a four-year institution. The literature provides relevant information regarding the process for assigning the ratings and how the cut-score is determined. Graphical analysis provides the visual assessment of an appropriate design, and causal interference validates the model. A local linear regression procedure is performed to recognize a neighborhood that optimizes precision while controlling for bias. A two-stage least square regression is utilized to perform the mathematical estimates. The results of this study indicate that remediation does not affect the likelihood that Colorado Community College students will transfer to a four year
institution. It is suggested that remediation, in and of itself, will not lead to increased transfer production desired by the Colorado Community College System. The results further indicate that the randomness associated with a single cut score may not accurately measure college readiness and may rather lead to students being over-placed into remediation. Students on the margin are able to master college algebra. The results of this study offer a number of assessment policy considerations encouraging the use of multiple measures. Student success (i.e., transfer) depends on a variety of cognitive and non-cognitive skills and attributes, and any single measure on its own cannot provide a comprehensive assessment. Implications for research, policy, and practice are discussed.
DEDICATION

To the students in the Colorado Community College System, especially those enrolled at Pueblo Community College, for their courageous pursuit of a life enriched by the means of a degree in higher education.
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CHAPTER 1
INTRODUCTION

The Colorado Community College System (CCCS) and its 13 complex colleges have evolved into the largest system of higher education in the State of Colorado. The role and mission of CCCS is reflective of community colleges throughout the United States: to provide an accessible, responsive learning environment (AACC, 2014). Community colleges strive to facilitate the achievement of student’s educational, professional, and personal goals in an atmosphere that embraces academic excellence, diversity, and innovation. Accordingly, the conglomeration of CCCS institutions offers a broad array of comprehensive educational, social, and economic functions.

However, the Colorado community colleges find themselves at a critical juncture. There is a clarion call for productivity improvement in higher education, and Colorado’s response is a performance-based funding model that promises to challenge community college policy makers to think beyond access and affordability to include persistence and transfer to four-year institutions. In an era of declining resources and escalating expectations, policymakers and educators alike remain concerned about the low number of students who make the transition to a four-year college or university successfully. Handel (2007) suggested, “the number of students lost in the transfer process represents both a waste of individual talent and a failure of America’s higher education establishment” (p. 39).
With encouragement from major partners in American higher education, including the Lumina Foundation, the National Governors Association, and the U.S. Department of Education, performance-based funding is emerging as a popular higher education financing and productivity improvement strategy (American Association of State Colleges and Universities, 2012). This is particularly evident in Colorado with the passage of House Bill 14-1319, a performance funding model that largely champions completion rates and student progression toward a certificate or degree (Colorado Commission on Higher Education, 2013). Colorado joins a growing cadre of states (Figure 1.1) implementing such policy initiatives linking appropriations and campus performance, maintaining focus on the goal of improving college completion, while rewarding both progress and success.

**National Perspective**

*Figure 1.1. Cadre of States Implementing Performance Based Funding (Illustration provided by CDHE, 2014).*
 Appropriately, the Colorado Community College System (CCCS) considers the transfer of its students to four-year institutions an important component of meeting its mission of facilitating the educational success of students. Addressing this educational attainment goal requires a dedicated effort to develop institutional policies that will yield a larger proportion of students across the degree completion finish line. In order to realize this nation’s “achievement agenda,” students need to not only find their way to college, but also be successful once there (American Association of State Colleges and Universities, 2012).

However, defining student success within CCCS can be a complicated task. The 151,300 Colorado students enroll with unique criteria, varied levels of academic competence, and a plethora of social cognitive variables. Bahr (2013) said it best:

Students generally are free to pursue a credential or not, to come and go from the institutions from semester to semester, to attend part-time or full-time, to declare a major late or not at all, to modify their academic objectives without involvement of the bureaucratic structures of the institution, to enroll in any coursework in any program of study if they meet the prerequisites (and, not infrequently, regardless of whether they meet the prerequisites), and so on. (p. 139)

The successful completion of college algebra is identified as one possible predictor of transfer. “College algebra remains a required, core course for all majors at a community college, and successful completion of the course is considered a gateway to further success in higher education” (Wynegar & Fenster, 2009, p. 2). The magnitude of
this topic is such that college algebra enrolls a larger number of students than other college mathematics courses in the nation’s community colleges (Reyes, 2010).

For the Colorado community college student, however, the mastery of college algebra is not universally achieved. CCCS educational policy champions college algebra as a gateway course, and yet the scale of postsecondary remediation—specifically the need for math remediation—presents a significant barrier for CCCS students considering transfer to four-year institutions. WestEd, a national nonpartisan, non-profit research, development, and service agency, reported that each year, more than two-thirds of students entering public two-year colleges in the United States are required to take one or more remedial classes before they can enroll in courses that carry college credit. Likewise, CCCS reported that in academic year 2012-2013, there were over 68,000 enrollments in remedial courses throughout the community college system. Of the total CCCS enrollments, more than 58.5% were in one of the 24 remedial math courses offered. Table 2.1 [located in Chapter 2 of this study] provides a breakdown of the remedial mathematic courses offered with-in CCCS.

There remains, however, considerable debate on the benefits of remediation in a community college. Although remedial classes are intended to ensure students’ success, they are often considered unnecessary or even a self-defeating step, slowing student progress toward postsecondary transfer or leading students to give up completely (Bracco, 2014). In view of this, many students who are deemed “college ready” by virtue of their placement scores or completion of developmental coursework still do not transfer (Roksa, Jenkins, Jaggars, Zeidenberg, & Cho, 2009). The fact that even academically
proficient students have trouble persisting and transferring to a four-year institution suggests that college readiness encompasses more than just academic skills.

Student precollege attitudinal and motivational traits have been identified as important internal dimensions shaping individual behaviors that are especially relevant for studying community college transfers (Wang, 2009). McGrew (2007) found that individual differences in academically related characteristics can make for success or failure in one of life's most important pursuits—obtaining an education. Eccles and Wigfield (2002) suggested that researchers are now treating intrinsic motivation as less of a situation-specific state and more of a trait-like characteristic. In an academic context, the highly correlated components of the trait (intrinsic motivation) include (a) academic learning driven by curiosity and interest, (b) a preference for hard or challenging academic tasks, and (c) a striving for competence and independent mastery (Eccles & Wigfield, 2002).

Wang (2009) reported, “relatively few studies, however, have focused on community college transfer students and the unique factors that predict their educational outcomes” (p. 570). Yet, Nora and Rendon (1990) suggested that no other community college function has received as much negative criticism as that related to transfer. Colorado represents an important state that reflects broader national trends in remediation policy, transfer production, and performance based funding. As such, the relevance of this research has the potential to contribute to important assessment policy considerations for CCCS and other community college systems. In addition, the findings of this study may have implications for practice at other community college systems that attempt to
formulate institutional placement policies regarding initial mathematics course placement.

**Purpose of the Study**

Advocates claim that remediation is an important, necessary, and effective component of higher education (McCabe, 2000). Yet Deil-Amen and Rosenbaum (2002) argued that remediation is a barrier that increases the requirements needed before taking college algebra, thereby lowering the completion and transfer probabilities. The purpose of this study, therefore, is to examine transfer production through a unique lens that examines the fact that college readiness in the CCCS is largely based on a single test math score.

One specific research question guides this study: Does math remediation affect the likelihood that a community college student will transfer to a four-year institution? For the purposes of this dissertation, remediation is specific to mathematics and defines remediation as a prescribed course designed to prepare students with weak academic skills in mathematics to succeed in college algebra.

By assessing CCCS students whose mathematics assessment fall just below and just above the cut score of 85, the research examines the community college’s complicated phenomenon of “college readiness” and specifically the relevance of a widely accepted treatment (remediation) on a student’s intent to transfer to a four-year institution. The results of this dissertation provide important policy considerations for those community college leaders in Colorado willing to acknowledge that: (a) academic preparedness and college readiness may not be one and the same for many community
college students, (b) transfer depends on a variety of cognitive and non-cognitive skills and attributes, and (c) any one measure on its own cannot assess all of them.

**Scope of the Study**

A type II fuzzy regression discontinuity design (RDD)-a quasi-experimental procedure—is utilized to assess the appropriateness of the CCCS college readiness policy and the Accuplacer® arithmetic placement cut score to estimate the effect of remediation on transfer to four-year institutions. RDD analysis is most appropriate in situations such as this, whereby students are identified for treatment (remediation) based on whether their value for a numeric rating (often called the rating variable) falls above or below a certain threshold or cut-point (Calcagno & Long, 2008). The dataset uses CCCS student records from students who enrolled for the first time in academic years 2009 and 2010 along with the associated transfer information, obtained from the National Student Clearinghouse®. Three groups of students are included in the definition of first-time undergraduate: (a) first-time, degree-seeking undergraduates, (b) first-time non-degree-seeking undergraduates who change to degree-seeking status, and (c) non-degree-seeking first-time undergraduates who graduated from a Colorado public or private high school (or its equivalent) during the previous academic year (CDHE, 2014).

The 2009 and 2010 student information is used to compile the dataset because this is the most complete information available from CCCS. Less than 30% of students who enroll full-time in community colleges complete an associate’s degree in three years (Rath, Rock, & Laferriere, 2013). This statistic is consistent with CCCS outcomes. Only 24.8% of CCCS students complete within 150% of normal completion time (Colorado Community College System, 2014).
CCCS students provide robust and credible information to explore and test the hypothesis presented in this research study. CCCS serves more students than any other system or institution in the State of Colorado. The demographics of CCCS students lends itself to a diverse target population of students who reflect the contemporary collegiate population as identified and described in the literature review.

Colorado’s community colleges educate 41% of the resident undergraduates in public institutions in Colorado. CCCS serves 49% of all minority undergraduate students engaged in higher education in Colorado. Minority students represent 36% of the total population, 59% of the students are female, and 55% of the students are under 25 years old. Of most interest to this study is that 58.8%, or 37,342, of the CCCS students enrolled in remedial education need some level of developmental math (Colorado Community College System, 2014).

Figure 1.2 provides a map of the locations of the 13 entrepreneurial CCCS community colleges and their 35 campuses.

![Figure 1.2. Colorado Community College map](image-url)
Theoretical Framework

This study utilizes the Self-Determination Theory (SDT) to drive the framework of data collection and assessment. Edward L. Deci and Richard M. Ryan (2000) are credited with introducing SDT, a theory of human motivation and personality. The scope of the theory includes individual growth tendencies and innate psychological needs. The research suggests that these two constructs are the basis for self-motivation, personality integration, and the conditions that fostered positive processes (Ryan & Deci, 2000). Accordingly, Ryan and Deci (2000) identified three innate needs that, if satisfied, allow for optimal function and growth: (a) competence, (b) autonomy, and (c) relatedness. Hadden, Overup, and Knee (2013) suggested that “taken together, SDT posits that all three are necessary for optimal functioning, and fulfillment arises out of the interaction between the person’s needs and the environmental context” (p. 275). Figure 1.3 illustrates the SDT framework.

![SDT Framework Diagram](image)

Figure 1.3. Self-Determination Theory

Ciani, Sheldon, Hilpert, and Easter (2011) further articulated the three elements of the self-determination phenomenon:
(1) Humans are inherently proactive with their potential and the mastering of their inner forces (drives and emotions). Accordingly, the need for competence relates to feelings of power and efficacy; the desire to control the outcome and experience mastery.

(2) Humans have an inherent tendency toward growth development and integrated functioning; therefore, the need for autonomy relates to the universal urge to be causal agents of one’s own life and act in harmony with one’s integrated self. [This construct was not intended to be independent of the others].

(3) Optimal development and actions are inherent in humans, but they do not happen automatically. The need for relatedness is associated with feelings of closeness and connectedness with others; the universal desire to interact, to be connected to, and experience caring for others.

SDT also proposes a broad distinction between intrinsic and extrinsic motivation, which is particularly pertinent to the need for autonomy, or the desire to experience behavior as self-initiated and self-regulated (McLachlan & Hagger, 2010). Intrinsic motivation is characterized by engaging in behavior for the sake of the behavior itself and for the outcomes of enjoyment, satisfaction, and fulfillment. Extrinsic motivation is evident when behavioral engagement is driven by factors external to one’s self, for example, gaining social approval and avoiding punishment (McLachlan & Hagger, 2010). A review of the three decades of research suggests that the quality of experience and performance can be very different when one is behaving for intrinsic versus extrinsic reasons.
Intrinsic motivation is not the only form of motivation, but it is a pervasive and important one. From birth onward, a healthy human is an active, inquisitive, curious, and playful creature, displaying a ubiquitous readiness to learn and explore, and does not require extraneous incentives to do so. This natural motivational tendency is a critical element in cognitive, social, and physical development because it is through acting on one’s inherent interests that one grows in knowledge and skills (Ryan & Deci, 2000).

Bilde, Vansteenkiste, and Lens (2011) proposed that intrinsically motivated and determined students are self-regulated learners who develop a positive attitude towards the learning task, put effort in it, and persist at it. In essence, effective self-regulation promotes learning performance (Liu, Wang, Kee, Koh, Lim, & Chua, 2014). These students draw from a wide repertoire of cognitive and metacognitive strategies, including the use of elaboration tactics, study aids, planning efforts, staying concentrated and monitoring effort by blocking out distracters, and evaluating one’s progress against a standard (Bilde et al., 2011).

The relationship between intrinsic motivation and performance has been supported in previous research. Cerasoli and Ford (2014) re-emphasized that intrinsically motivated students elicit higher levels of task persistence and show greater desire toward behaviors such as attending class and staying in school. Such students tended to have higher levels of confidence and persistence; this led them to implement more of the deep-level learning behaviors that have been found to predict higher exam scores (Cerasoli & Ford, 2014). Research has shown that SDT is quite useful in explaining student motivation and success in academic contexts (Ciani et al., 2011).
This research project begins with the premise that students enter community college with particular goal profiles and STD is used as a framework to understand how these goal profiles can ultimately lead to a four-year degree. Self-determination theory considers quality of motivation to be more important than quantity and has been shown to positively influence academic performance in students (Kusurkar, Cate, Vos, Westers, & Croiset, 2012). Chemolli and Gagné (2014) suggested that there are different types of motivation, such that people vary not only in level of motivation, but also in the source of quality of that motivation.

**Data Limitations**

This research is limited to CCCS students. Although the sample includes both urban and rural demographics, the data may not proportionally reflect all students enrolled in a community college. Accordingly, the aggregated data set is reflective of a “system” of collective community colleges governed by a State Board rather than a single community college governed by a local taxing district.

The use of RDD could also be questioned. This methodology has been widely used in other contexts to establish causal inferences when selection bias exists (Trochim, 1984). With the availability of new large data sources, RDD has increased credence when applied to the study of college readiness, (i.e., remediation in higher education). The precision of the RDD estimate, however, is dependent on the size of the analysis sample and the degree to which the sample is closely clustered around the cut point of interest (Murnane & Willett, 2011). Too large of a dataset may be impaired by bias. Trochim (1984) suggested that in the absence of a randomized experiment, RDD is most appropriate, but would not be considered as strong of a method.
The measure of the coefficient of determination ($R^2$) in the results is less than desirable. This is not surprising, however, given that there is so much unknown about the CCCS students’ intrinsic motivation, behavior, and attitude upon application to a Colorado community college, completion of the Accuplacer® arithmetic assessment, and the personal effectiveness of remediation upon the students. Such data is not currently collected upon admission to a CCCS college nor is it collected upon graduation.

**Model Limitations**

Despite the growing importance of RDD in economics, there are few comprehensive summaries of what is understood about RDD—when it succeeds, when it fails, and its strengths and weaknesses. The RDD estimator compares the outcome of people who are just on both sides of the discontinuity; difference in means between these two groups is an estimate of the treatment effect at the discontinuity point. The RDD says nothing about the treatment effect away from the discontinuity, which is a limitation of the RDD effect. In addition, while a nonparametric approach establishes the appropriateness of the bandwidth, the correctness of the distribution can never be proven to be correct (Lee & Lemieux, 2010).

**Key Definitions**

*Academic Preparedness:* One factor of college readiness - the measurement of a student’s knowledge and skills (e.g., math).

*ACT®:* The ACT® is a curriculum- and standards-based educational and career planning tool that assesses students’ academic readiness for college.

*Bandwidth:* The range of points on each side of the cut-score that will be included in a local linear regression.
**Bin Width:** The width of the bin on the rating scale. Also called bin size.

**Cross-validation:** A method used to find the optimal bandwidth for graphical or other analysis.

**College Readiness:** The combination of skills, knowledge, and habits of mind necessary to participate fully in college level courses (courses at the 100 level and above) to completion.

**Cut-Score:** An assignment criterion, which characterizes a regression discontinuity design. The cut-score forms the rule for assigning persons (students) to treatment (remediation).

**Fuzzy Regression Discontinuity:** Some treatment group members do not receive treatment and are referred to as “no-shows.” Some treatment group members receive treatment and are referred to as “cross-overs.”

**Gateway Course:** A course that may or may not be credit bearing, but is foundational in nature for a degree-seeking student.

**Intrinsic Motivation:** Stimulation that drives a student to adopt or change a behavior for his or her own internal satisfaction or fulfillment.

**Multiple Measures:** The use of more than one measurement to determine student placement in college-level courses.

**Nonparametric Estimation:** An estimation technique that does not assume a particular functional form but rather constructs one according to the information derived from the data.
Regression Discontinuity Design: A before-and-after two-group design where persons (students) are assigned to either the treatment or control group solely based on a cutoff score assignment criterion (Accuplacer® Arithmetic Assessment).

Remediation: A prescribed course designed to prepare students with weak academic skills in mathematics to succeed in college algebra.

SAT®: A globally recognized college admission test that lets students show colleges what they know and how well they can apply that knowledge. It tests students’ knowledge of reading, writing, and math subjects taught every day in high school classrooms.

Sharp RD Design: All subjects (students) received their assigned treatment (remediation) or control condition.

Social Cognitive Factors: The psychological needs of feeling, emotion, and desire. These human behaviors are influenced by personal, behavioral, and environmental constructs.

Transfer Production: The academic advancement from a two-year to a four-year institutional of higher education.

Whole Student: A term used to describe all aspects of a student—intellectual, psychological, and social.

Organization of the Dissertation

The dissertation is organized into five chapters. Chapter 1 is an overview of the study, including the purpose and scope of the study, the theoretical framework, and limitations. Chapter 2 is the review of the literature. Chapter 2 includes the examination and understanding of the transfer student, (specifically, the CCCS transfer student),
college algebra—the universal gateway to transfer to four-year institutions, the scale of postsecondary remediation in higher education and CCCS, the appropriateness of the Accuplacer® assessment on predicting “college readiness,” and the social cognitive factors that impact community college students’ academic performance. Chapter 3 describes the methodology of the study, including data collection and analysis. Chapter 4 reports the results and findings of the data collected. Chapter 5 reports the conclusions of the researcher, as well as a summary and discussion of policy implications and recommendations arising from the study.
CHAPTER 2
REVIEW OF THE LITERATURE

This literature review is organized around five major topics: (a) understanding the transfer student, and specifically, the CCCS transfer student, (b) college algebra—the universal gateway to transfer, (c) the scale of post-secondary remediation in higher education and CCCS, (d) the appropriateness of the Accuplacer® Assessment on predicting “college readiness,” and (e) the social cognitive factors affecting community college students’ academic performance.

The Transfer Student

Lucas (1996) maintained that the niche of community colleges and the basis of their legitimacy are guided by an academic orientation that was driven by an emphasis on the transfer of students. However, defining a “community college transfer student” becomes a complicated issue. Students often combine community college and four-year campus courses; they enroll in more than one institution at a time, transfer back and forth between campuses, and take courses when and where they are most conveniently available to them. Arnold (2001) reported, “Students do not necessarily behave consistently with postsecondary education’s time worn data collection and interpretation practices that suggest that today’s students act as liberal arts college students did, say in the fifties, sixties, or seventies” (p. 58).

The definition of transfer has evolved into a discrete outcome rather than a continuous behavior (Hageborn, Moon, Cypers, Maxwell, & Lester, 2006). Cejda, Kaylor, and Rewey (1998) reported that most community college students transfer prior
to earning an Associate of Arts (AA) degree, as well as after earning degrees other than the AA. Research on the topics of student enrollment patterns and choices suggested that students today do not necessarily attend high school, community college, and a four-year institution in a linear fashion (Arnold, 2001). The research of Hageborn et al. (2006) reported that “traditional linear transfer is actually rare among urban students, and is thus the exception rather than the rule” (p. 237).

Students enroll at community colleges for many reasons. Porchea, Allen, Robbins, and Phelps (2010) reported that 36% of community college students enroll with the intent to transfer to four-year institutions, while 35% enroll with the desire to obtain an associate’s degree, and 29% enroll to pursue personal interests. Bahr (2011) described the transfer student as one who remains at the institution for the longest period of time, takes full-time course loads, enrolls in both the greatest number of units of course work overall, and the greatest number of units of transferable math. These students succeed in their courses 77% of the time (Bahr, 2011).

**The Colorado community college transfer student.** Facilitating the achievement of student educational goals is an important component of the mission of the Colorado Community College System (CCCS). The published CCCS mission statement reads as follows:

The Colorado Community College System (CCCS) is the statewide pathway to individual achievement and economic vitality. We provide an accessible, responsive learning environment that facilitates the achievement of educational, professional and personal goals by our students and other members of our communities, and we foster an
atmosphere that embraces academic excellence, diversity and innovation (CCCS, 2014).

CCCS (2014) professes that the educational goal of many Coloradans is a baccalaureate or higher degree, and for a number of students, a community college is the first step toward attaining that goal. Ultimately, though, students must transfer from a CCCS college to a four-year institution to achieve their goal of a baccalaureate degree. Tracking transfer production—the number of students who transfer from a CCCS college to another institution of higher education—helps CCCS measure its success in facilitating the educational goals of this segment of its student population.

To obtain the broadest information available on student transfers, CCCS matches its students with National Student Clearinghouse® (NSC) data (CCCS, 2014). NSC collects enrollment data from colleges and universities throughout the United States; the institutions that provide data to NSC enroll over 98% of the nation’s postsecondary students (NSC, 2014). By using the NSC database, CCCS can obtain data on transfers to out-of-state as well as to in-state institutions, including public and private colleges, two-year colleges, and four-year institutions.

A total of 12,655 students attending a CCCS college in fall 2012 transferred to another institution of higher education in fall 2013. This number is 14.1% of the 89,868 students submitted to NSC for matching. A student is counted as a transfer if he or she enrolls in a different institution of higher education in the subsequent fall, regardless of whether the student earned a credential at the originating CCCS college (CCCS, 2014).

Of the 12,655 CCCS students, a majority of them, 91.1%, transferred to a four-year institution with 83.9% of students attending a public institution. Of those at public
colleges, 90.1% attended a four-year college. Over the last five years, the percentage of transfers attending a four-year college has remained relatively consistent, averaging 91.5% (CCCS, 2014).

The Colorado Department of Higher Education (CDHE) also produces a report on transfers. The CDHE report is based on data that are more limited than the data provided by NSC. The CDHE report does not include out-of-state institutions and its data from in-state private schools is limited. The CDHE report for public in-state institutions relies on information provided by the transfer college that may result in an underreporting of CCCS transfers. For comparison, CDHE's 2012-13 report identifies 6,210 CCCS transfers, while NSC data identifies 12,655 transfers (Colorado Department of Higher Education, 2014).

Hagedorn et al., (2006) suggested that transferable course credits completed is the basis for transfer, not stated academic goal or intention. Forty-six percent of CCCS students who transferred in fall 2013 had earned between one and twenty-nine credit hours at the time of their transfer (CCCS, 2014). Porchea, et al., (2010) reported that it was the students with degree expectations of Bachelor of Arts/Bachelor of Science—not AA or Associate of Science—who were much more likely to transfer to a four-year institution, regardless of whether they first obtained a degree. However, 69% of all CCCS students who transferred had declared an intention to earn some type of associate degree, while 27.7% did not identify a particular course of study (Colorado Community College System, 2014).

Hagedorn, Cypers, and Lester (2008) claimed, “community college students generally express high academic aspirations” (p. 644). The self-reported academic goals
of such students appeared to influence their academic behaviors. The successful transfer students enrolled and passed courses in transfer-level mathematics, as well as in other courses.

**College Algebra–The Universal Gateway to Transfer**

A data brief published by Augusta Technical College (2013) reported that gateway courses are defined as introductory college-level courses that students are required to complete before enrolling in advanced college-level courses. The mastery of the curriculum of gateway courses is essential for continued student success. College algebra is identified as such a course and is required for most majors. College algebra is also viewed by many students as a gatekeeper course for degree completion (Reyes, 2010). The successful completion of an arithmetic gateway course is extremely important for most community college students and is no different for the Colorado community college students who aspire to progress toward successful transfer to a four-year institution.

Algebra is, in short, the gateway to success in the 21st century (Herriott & Dunbar, 2009). What is more, when students make the transition from concrete arithmetic to the symbolic language of algebra, they develop abstract reasoning skills necessary to excel in math and science. Herriott and Dunbar (2009) further suggested that from the perspective of most mathematicians, the role of the college algebra course is to prepare students for advanced academia. Conley (2007) supported the notion that students need a thorough understanding of the basic concepts, principles, and techniques of algebra. Basic math competencies include the conceptual understandings to specify and solve a problem, as well the ability to interpret a solution.
College algebra provides students a college level academic experience that emphasizes the use of algebraic functions in problem solving. Modeling provides a foundation in quantitative literacy and supplies the algebra and other mathematics needed in partner disciplines. College algebra helps meet quantitative needs in and outside of academia. Conversely, however, there is a substantial amount of literature that reported college algebra was a barrier for many students (Thiel, Peterman, & Brown, 2008).

The Augusta Technical College Brief (2013) suggested that success in gateway courses is a greater challenge for students than college-level courses that come afterward. The report concluded that students who are able to move successfully past gateway courses do well in the other college level program courses. Wynegar and Fenster (2009) further reported that college algebra has often had the lowest pass rate of any course on a community college campus. For the majority of community college students, enrollment in college algebra is dependent on the completion of a developmental mathematics program.

Non-selective public institutions provide the bulk of remediation, the point of entry for 80% of four-year students and virtually all two-year students (Bettinger & Long, 2004). Because students who attend nonselective institutions are almost assured admission into these schools, the remediation placement exam taken once arriving on campus is the key academic gatekeeper to postsecondary study (Bettinger & Long, 2004).

**Scale of Postsecondary Remediation**

The National Center for Education Statistics (NCES) (2003) defines “remediation” as coursework that is being retaken. The NCES further reports that public two-year colleges are more likely than other types of institutions to provide remedial
education. The most common approach for identifying those in need of remedial coursework is to give a standardized assessment test to all entering students (NCES, 2003).

Remedial math had become an insurmountable barrier for many students, ending their aspirations for higher education (Bryk & Treisman, 2010). The research of Attewell, Lavin, Domina, and Levey (2006) found that “among the traditional college students covered by the National Educational Longitudinal Study (NELS: 88) survey, 40% took at least one remedial course in college. Mathematics was the most common remedial subject, with 28% of students taking courses in that area” (pp. 897-898). Many students repeat remedial math courses up to six times. “Fewer than one in 10 students referred to three or more semesters of remedial math ended up completing the first-year college-level math course for which they were preparing” (Mangan, 2012, p. 13). Roach (2009) reported that the gatekeepers for students who have the goal of transferring to four-year institutions are the remedial education programs.

Unfortunately, the need for remediation in institutions of higher education is not a new or contemporary phenomenon. Phipps (1998) reported:

Beginning with Harvard College in the 17th century, where tutors in Greek and Latin were provided for underprepared students, and continuing into the middle of the 20th century with the establishment of the G.I. Bill, remediation for inadequately prepared students has been an integral part of American education (p.5).

The need to help underprepared students has been embedded in the nation’s higher education system for well over three centuries.
Because mathematics is a universal requirement for all students, institutions of higher education—particularly community colleges—are spending a considerable amount of resources in preparing the large number of students who are not ready for college level work (Mesa, 2012). The increasing need for postsecondary remedial education is believed to be one of the most important educational problems in America today (Bahr, 2008).

As such, CCCS reported that in academic year 2012-2013, 37,342 individual students enrolled in remedial courses throughout the CCCS. These 37,342 students took 67,636 remedial courses throughout the community college system. This equates to 26.4% of the overall headcount for academic year 2012-2013. As Table 2.1 indicates, of the total enrollments in remedial courses, 58.8% were in one of the 24 math courses offered.

Table 2.1.

Remedial math course enrollments throughout CCCS by term.

<table>
<thead>
<tr>
<th>Course</th>
<th>Summer 2012</th>
<th>Fall 2012</th>
<th>Spring 2013</th>
<th>Total</th>
<th>Percentage of Total Remedial Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT030</td>
<td>772</td>
<td>1438</td>
<td>553</td>
<td>2763</td>
<td>4</td>
</tr>
<tr>
<td>MAT045</td>
<td>660</td>
<td>2685</td>
<td>3,27</td>
<td>6472</td>
<td>10</td>
</tr>
<tr>
<td>MAT060</td>
<td>1104</td>
<td>3538</td>
<td>2288</td>
<td>6930</td>
<td>10</td>
</tr>
<tr>
<td>MAT070-074</td>
<td>19</td>
<td>125</td>
<td>220</td>
<td>364</td>
<td>1</td>
</tr>
<tr>
<td>MAT075</td>
<td>0</td>
<td>19</td>
<td>2</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>MAT077-087</td>
<td>11</td>
<td>280</td>
<td>181</td>
<td>472</td>
<td>1</td>
</tr>
<tr>
<td>MAT090</td>
<td>15430</td>
<td>5209</td>
<td>5036</td>
<td>11788</td>
<td>17</td>
</tr>
<tr>
<td>MAT095</td>
<td>0</td>
<td>45</td>
<td>164</td>
<td>209</td>
<td>0</td>
</tr>
<tr>
<td>MAT096</td>
<td>0</td>
<td>108</td>
<td>143</td>
<td>251</td>
<td>0</td>
</tr>
<tr>
<td>MAT099</td>
<td>1197</td>
<td>4849</td>
<td>4441</td>
<td>10487</td>
<td>16</td>
</tr>
<tr>
<td>All Math</td>
<td>5,306</td>
<td>18,296</td>
<td>16,155</td>
<td>39,757</td>
<td>59</td>
</tr>
</tbody>
</table>

Totals by subject are based on the sum of all remedial levels in each subject.
CCCS (2013) further reported that over the last five years, total student headcount increased by 20.5%, while the number of students taking a remedial course increased 50%. Within this time frame, the proportion of students enrolled in remedial courses peaked in 2010-2011 and has declined in the two years since. CCCS remedial enrollments make up 11.7% of all course enrollments, up from 10.1% five years ago, but down from 12.9% in 2011-2012. Over the last five years, growth in remedial enrollments averaged 9.5% per year while state funding for this coursework has been completely eliminated.

McCabe (2000) has argued that many promising students enter community colleges with the need to rebuild certain skills. Many of the students in need of remediation subsequently complete their degrees successfully. Of all CCCS remedial course enrollments, 69.5% were completed successfully in academic year 2012-2013. Course completion is defined as receiving a passing grade—an A, B, C, or Satisfactory—at the end of the term. The cohort for calculating completion rates is the sum of passing and failing grades and overall, rural colleges have higher course completion rates than urban institutions. CCCS schools with Hispanic Serving Institution (HSI) status—as a group—have lower math course completion rates (65.7%) than do non-HIS schools (69.5%).

Most students who are classified as remedial in mathematics are simply those who have the lowest scores on the placement assessment, and Phipps (1998) has suggested that the line that separates those who need remediation from those who do not is fairly arbitrary. The literature supports the notion that standards for remediation vary considerably from one community college to another, and not all remediation is delivered effectively or efficiently (Phipps, 1998).
Bryk and Treisman (2010) suggested that students do not understand the relationship between remedial math, college algebra requirements, and the competencies needed for future success. The fear of math, the need for remediation, or a lack of interest in algebra causes many community college students to avoid the course as long as possible, often delaying progress toward a degree. Regardless, students cannot escape the fact that college algebra is unavoidable.

**Appropriateness of the Accuplacer® Assessment**

It is common practice for colleges and universities to identify students as under-prepared for a college-level course based on standardized placement scores (Kozeracki, 2002). What constitutes “college-level” work, however, is unclear. There is “a great deal of variation across colleges and universities as to what constitutes a remedial course and how students are selected into remediation” (Bettinger & Long, 2004, p. 9). The research of Scott-Clayton, Crosta, and Belfield (2014) concluded that “severe mis-assignments are common using current test-score-cutoff-based policies, with ‘under placement’ in remediation much more common than ‘over placement’ college courses” (p. 371).

Scott-Clayton et.al., (2014) claimed that remediation is one of the largest single interventions intended to improve outcomes for underprepared college students, yet little is known about the remedial screening process. Institutions differ on the protocol, and there are no generally agreed upon cut-offs below which college students require remediation: each college follows its own set of practices.

The U.S. Department of Education reported that accurate assessment of students’ remedial needs has been an ongoing concern since the 1990s. As educators repeatedly
raise questions about the validity of placement tests, the lack of consensus on what constitutes college readiness has been exacerbated. Critics of placement policies for remedial students contend that the procedures for evaluating students’ academic skills vary considerably across institutional missions and types (Scott-Clayton et al., 2014).

Currently, two remedial placement exams dominate the market (Scott-Clayton et al., 2014). Fields and Parsad (2012) reported that the Compass® was developed by ACT and is used by at least 46% of community colleges. The Accuplacer® was developed by the College Board and is used by at least 62% of community colleges (Fields & Parsad, 2012).

CCCS joined over 1000 institutions in North America in utilizing the Accuplacer® assessment as its placement tool. The CCCS Board Policy 9-41 (Basic Skills Assessment) is located on the CCCS website and is articulated as follows:

First-time undergraduate students must bring to the community college documentation of ACT® or SAT® scores. If the student either does not have scores from these standardized assessments, or if the scores are not at the Colorado Commission of Higher Education identified level, then the college will assess the student using the Accuplacer assessment instrument. Each enrolled first-time undergraduate student at each of the CCCS community colleges shall be: (a) assessed in Mathematics, Writing, and Reading, (b) advised to enroll in remedial skill classes during the first semester following a placement test when assessment scores indicate inadequate college preparation in any or all of these areas, (c) advised of his/her responsibility to complete remedial course work within the first 30
semester hours, and (d) provided with written notification identifying which state institutions offer such basic skills courses, including any electronic on-line courses.

Table 2.2 illustrates the Accuplacer® arithmetic assessment placement cut scores that have been designated by the CCCS.

Table 2.2

<table>
<thead>
<tr>
<th>Course</th>
<th>Accuplacer cut scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT030</td>
<td>25-56</td>
</tr>
<tr>
<td>MAT060</td>
<td>&lt;45</td>
</tr>
<tr>
<td>MAT090</td>
<td>45-60</td>
</tr>
<tr>
<td>MAT099</td>
<td>61-84</td>
</tr>
<tr>
<td>College Math</td>
<td>85+</td>
</tr>
</tbody>
</table>

Mellard and Anderson (2007) best described the Accuplacer® assessment as follows:

The assessment is an online adaptive placements test that consists of nine subtests covering reading, writing, mathematics, and English language skills for non-native speakers. The assessment’s content was established by committees of subject matter specialists and developed to conform to national standards such as the National Council of the Teachers of Mathematics and the Educational Testing Service. Norming samples were drawn from data voluntarily submitted by institutions. Scores and diagnostic feedback are generated immediately and interpreted using the placement rules established by the particular institution (p. 14).
The validity of the Accuplacer® assessment lies in its ability to predict course grades in college curriculum. Its reliability is demonstrated by internal consistency ratings of .86 - .92. The test/retest reliability ranged between .73 - .96 (Mellard & Anderson, 2007).

Correlations between a single standardized test, (i.e., the Accuplacer® assessment), and course grades appear to be adequate, demonstrating a positive correlation. However, the correlations are likely to be weaker because non-cognitive skills and attributes, (e.g., student behaviors, intrinsic motivation, and perseverance), have greater effects on course grades, and these factors are not taken into account by multiple measures (Bracco, 2014). As a proponent of multiple measures, Bracco further reported:

Currently, 92% of the nation’s community colleges assign students to remedial classes based on the results of a single standardized placement test. But the research shows that these tests can have high rates of “severe error,” particularly when used as the sole basis for course placement. (p. 15)

The instruments vary between standardized assessments and institutional-developed subject-area tests. Some schools augment placement tests with high school transcripts to make assignments. The cut-off score used to determine placement differs among institutions and reflects the different interpretation of what comprises college-level coursework (Bettinger & Long, 2004). As a result, students who might be placed into remedial courses in one institution may very well be placed into college-level courses at another college or university.
As Adelman (1998) spelled out, postsecondary course requirements and content are not comparable across institutions. Thus, assessment cut-scores must differ accordingly. Scott-Clayton et al. concluded, “The use of more accurate screening tools would enable institutions to remediate substantially fewer students without compromising college success” (p. 371).

**Social Cognitive Factors Affecting Academic Performance**

Sheldon (2009) stated that “an assessment of the relative influence of social background characteristics, academic experiences, and the organizational context of the community college on the decision to transfer is warranted” (p. 40). CCCS educates a diverse population of students who represent a wide range of backgrounds and expectations. Many students are underserved and have special educational and personal needs that must be met in order for them to succeed. Howell (2011) pointed out that, “by the time students reach college, their ability to handle college-level coursework is based not only on their academic ability and effort, but on a cumulative set of influences from family, teachers, peers, and school” (p. 292).

With open access admission, CCCS colleges provide a democracy of education to every citizen age 16 and older in the State. The result of a study conducted by Morrow and Ackerman (2012) encourages college personnel to look beyond demographics and academic preparedness and suggested that social cognitive factors are important components of student engagement, persistence, retention, and transfer. Tinto (1993) asserted that students enter an institution of higher education with a plethora of social cognitive constraints that shape their level of commitment for completing their degree. As a result, the literature review will further identify those social cognitive factors.
Social cognitive variables include interest in school, willingness to study, persistence, time spent on outside activities, and encouragement from parents (Ransdell, 2001). “While intelligence matters, by itself it is no guarantee of success” (Bond, 2014, p. 30). Students with high levels of social and academic integration tended to have high levels of predisposition to transfer (Nora & Rendon, 1990). Along these same lines, Heckman and Rubinstein (2001) suggested, “it is surprising that academic discussions of skill and skill formation almost exclusively focus on measures of cognitive ability and ignore social cognitive skills” (p. 145).

Conley (2007) suggested that there is a major distinction between academic preparedness for college and “college readiness.” The literature suggested that while core academic skills and content knowledge are commonly recognized as college readiness skills, other skills also help shape readiness to do college-level work. Roderick, Nagaoka, and Coca (2009) offered this explanation:

Economists have characterized skills that determine educational achievement but are not measured readily by standardized tests or directly taught as content as “non-cognitive skills.” Non-cognitive skills include a range of behaviors that reflect greater student self-awareness, self-monitoring, and self-control—study skills, work habits, time management, help-seeking behavior, and social problem-solving skills. Meeting the developmental demands of college requires behavioral, problem-solving, and coping skills that allow students to manage successfully new environments and the new academic and social demands of college. (p. 190)
Consistent with the framework of this research project, Ransdell (2001) suggested that “self-reports of students’ ability to adapt to the demands of college life are social cognitive predictors of college success” (p. 360). For first-time students, college is a significant life transition. Stress and related coping behaviors are social cognitive variables that affect student persistence and course completion (Galatzer-Levy, Burton, & Bonanno, 2012).

The literature review also provides an abundance of scholars who corroborated the relevance of the theoretical framework of this research project and the constructs of self-determination theory. Schuetz (2008) stated that “even more than the right academic preparation or freedom from adult responsibilities of work and family, community college students who experience a robust sense of belonging, competency, and autonomy will naturally be more engaged” (p. 26). Hartley (2011) suggested that intrapersonal resilience, such as (a) tenacity and persistence (b) emotional intelligence, (c) the ability to handle stress, (d) positive acceptance of change and self-control, (e) spirituality, as well as interpersonal resilience (i.e., social support) can explain the variances in academic persistence.

A report issued by the Basic Behavioral Science Task Force of the National Advisory Mental Health Council in 1996 suggested that early-attachment experiences, genetics, and other environmental factors such as school and family are dynamic constructs of resilience (Parr, Montgomery, & DeBell, 1998). Martin and Dowson (2009) contributed that “individuals develop beliefs, orientations, and values that are consistent with their relational environment” (p. 327). Attributes of resilient students include being socially adept, having a positive outlook on life, having a vision and sense
of mission, accepting responsibility and taking risks, being creative and having a sense of humor, being able to monitor and regulate emotions, and having insight and being perceptive (Parr et al., 1998).

Attitude, motivation, and determination are intrinsically linked to beliefs, values, and goals with action (Eccles & Wigfield, 2002). Accordingly, beliefs, values, and goals all lend themselves to reasons why students choose to engage or disengage in different activities that relate to achievement behaviors. Engagement, or lack thereof, can be influenced when there is a large discrepancy between the content of a message and an individual’s self-attitude (Hames & Joiner, 2012). Vansteenkiste, Lens, de Witte, and Feather (2005) also suggested that “autonomous behaviors are regulated by the process of choice and volition, which is reflected in people experiencing a full endorsement of, or sense of willingness to, engage in a behavior” (p. 272).

Petrides (2010) contributed to this study by suggesting that personality traits (social cognitive attributes) also present a tendency to perceive convergences and divergences between an individual’s belief that he/she can attain certain goals and the importance he/she places on these goals. Extraversion, emotional stability, agreeableness, conscientiousness, and openness to experience have been identified as the “Big Five” personality traits (Ridgell & Lounsbury, 2012). New to the research are the phenomena of work drive and academic ethic, both of which have been found to be predictors of college grades (Ridgell & Lounsbury, 2012). April, Dharani, and Peters (2012) added yet one other personality construct, the locus of control, which reflects one’s beliefs about who controls life and the environment. Although the research has numerous theories to consider, “Most past studies have treated motivation as a
personality trait, and have overlooked the importance of dynamic and situational viewpoints” (Ishimura & Kodama, 2009, p. 47).

The research also suggested that a student’s personal academic goals are established well before applying or enrolling in an institution (Plante, O’Keefe, & Theoret 2013). Reinhard and Dickhauser (2011) added that academic goals and performance expectancies depend on an individual’s perceived ability and task difficulty. Goals derived from individual expectancies can be a predictor of their subjective value for persistence and completion. Plante et al., (2013) defined a subjective value as the reason for engaging in a specific task and suggested that value will look different to each individual:

1. Attainment value – the personal importance of doing well on a task.
2. Intrinsic value – the enjoyment derived from performing an activity based on an individual’s personal interest.
3. Utility value – how well a task or domain relates to current and future goals.
   a. the negative aspects of engaging in a task
   b. performance anxiety
   c. fear of both success and failure
   d. the amount of effort needed to succeed
   e. lost opportunities that result from making one choice rather than another

Just as the values and reasons for student engagement may differ, the decision to engage is derived from two different classes of decision tasks: description-based and experience-based (Kudryavtsev & Pavlodsky, 2012). Decisions based on statistical
descriptions (description-based decisions) are derived from detailed information that usually includes the probabilities of possible outcomes. Experience-based decisions are formulated based on past personal experience. Individual choices are predicated on the outcomes they expect and the values they ascribe to those expected outcomes (Borders, Earleywine, & Huey, 2004).

The literature clearly articulates that people are purposeful beings who behave in accordance with their expectations and that their efforts resulted in outcomes they valued (Hancock, 1995). Linnenbrink and Pintrich (2002) subscribed that since the 1980s there has been a sustained research focus on how motivational and cognitive factors interact and jointly influence student learning and achievement. There is now recognition that students need both the cognitive skill and the motivational will to do well in school. This literature review concludes with a contribution from Pintrich (2003) who suggested:

Researchers interested in basic questions about how and why some students seem to learn and thrive in school contexts, while other students seem to struggle to develop the knowledge and cognitive resources to be successful academically, must consider the role of motivation (p. 667).
Rationale

Colorado’s remedial education policy provides criteria for public higher education institutions to identify students who need remedial courses in mathematics. Remedial education, also called developmental education, refers to classes intended to bolster the basic skills of new college students so they are adequately prepared for college-level work. These classes may be non-credit courses and may not be covered by student’s financial aid. The Colorado statewide remedial education policy applies to all state-supported institutions of higher education and is designed to ensure that all enrolled first-time undergraduate students are prepared to succeed in college-level courses. The governing boards and institutions of the public system of higher education in Colorado are obligated to conform to the policies set by the Colorado Department of Higher Education (CDHE) (Commission) within the authorities delegated to it by Colorado Revised Statute 23-1-113.3. The statute states:

Commission directive–basic skills courses: On or before September 1, 2000; the Commission shall adopt and the governing boards shall implement standards and procedures whereby basic skills courses, as defined in Section 23-1-113 (4) (c), may be offered by state institutions of higher education pursuant to this section (CDHE, 2011).

Typically, students achieving an assessment score at or above the college-ready cut scores may be placed into a college-level class. Students who do not achieve a high
enough assessment score or who fail to reach the college-ready cut score are given a secondary evaluation (determined by the institution), which is used to determine whether remedial classes are needed. Accordingly, Colorado college readiness mathematics assessment cut scores have been established and are presented in Table 3.1.

**Hypothesis and Research Question**

**Hypothesis.** The basis of this study submits that a community college students’ drive toward transfer is not diminished by an assessed need for math remediation. As such, it is recognized that a college readiness assessment score that falls above or below the threshold within a narrow neighborhood of the cutoff may simply be a result of randomness (Calcagno & Long, 2008). The hypothesis argues that the student who fails to meet the cut score is every bit as likely to transfer as the student who is deemed to be college ready.

**Research Question.** A single research question is addressed in this study. Does math remediation affect the likelihood that a community college student will transfer to a four-year institution?

This study is focused on the Accuplacer® assessment, although Colorado accepts three assessment instruments for determining if the first-time student is college ready in mathematics based on relevant cut scores (CDHE, 2011). The CCCS college readiness assessment cut scores align with the CDHE cut scores presented in Table 3.1. The ACT® and SAT® are used as secondary evaluations. Cut scores may be adjusted higher or lower based on empirical data of student performance in college mathematics courses. However, the scores presented have not been adjusted since 2004, and only then was the SAT sub-score decreased from 470 to 460 (CDHE, 2011).
Table 3.1

*CDHE College Readiness Assessment Cut Scores*

<table>
<thead>
<tr>
<th>ACT® Sub Score</th>
<th>SAT® Sub Score</th>
<th>ACCUPLACER® Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math: 19</td>
<td>Math: 460</td>
<td>College Math: 85</td>
</tr>
</tbody>
</table>

Exemptions from assessment include students who (a) have successfully completed college-level mathematics or (b) have successfully completed necessary remedial course(s), if required, in mathematics. Successfully completed refers to a student who earns a grade of C- or higher or a satisfactory completion (CHDE, 2011).

Students not meeting the specified minimum cut score may be placed in college-level courses and reported as such, provided that the student’s transcripts or other secondary-level assessment justifies such placement. There is no policy mention, however, of students meeting the specified minimum cut scores, who feel they are not adequately prepared for college level math. Such students are free to enroll in any remedial course offered. This scenario will be assessed in Chapter 4 of this dissertation.

A regression-discontinuity design (RDD) is utilized to take advantage of the CCCS Basic Skills Assessment Policy and the CDHE prescribed cut score of 85 to estimate the effect of remedial education on transfer. Basic skills courses designed for students deficient in the academic competencies necessary to succeed in a regular college curriculum include mathematics. These basic skills courses primarily cover concepts introduced in elementary algebra, geometry, and intermediate algebra (CCHE, 2014). The courses focus on word problems that would most likely be solved by arithmetic, knowledge of number systems (e.g., positive and negative numbers, square root, squares, percent, ratio, and conversion of fractions to decimals), simple equations, and finding information from a graph.
This RDD explores the statistical significance of remediation on transfer while controlling for a vector of Colorado community college student demographics. The RDD framework evaluates the effects of interventions or treatments (remediation) when assignment to treatment is determined completely or partly by the value of an observable assignment (variable: the Accuplacer ® arithmetic assessment score) (Marmer, Feir, Lemieux, 2012).

In this framework, identification of the treatment effect comes from a discontinuity in the conditional probability of treatment assignment (remediation) at some known cutoff value of the assignment variable. When assignment to the treatment is completely determined by the value of the assignment variable, the RDD is called sharp. However, as is the case of this study, when assignment to the treatment is only partly determined by the assignment variable, the RDD is called fuzzy. A type II fuzzy regression discontinuity design methodology captures those treatment group students who did not receive remediation (referred to “no-shows”) and those comparison group students who did receive remediation (referred to as “cross-overs”). Figure 3.1 conceptualizes the premise of a type II fuzzy regression discontinuity.
Targeted Population

Student data are a compilation of information from the thirteen Colorado community colleges and their 35 campuses: Arapahoe Community College, Aurora Community College, Colorado Northwestern Community College, Community College of Denver, Front Range Community College, Lamar Community College, Morgan Community College, Northeastern Junior College, Otero Junior College, Pikes Peak Community College, Pueblo Community College, Red Rocks Community College, and Trinidad State Junior College (Colorado Community College System, 2014). Figure 1.2 identifies the location of each college. The CCCS colleges represent a compilation of urban and rural students, socio-economic status, gender, and race.

This is a retrospective study that utilizes quantitative data regarding students enrolled in the CCCS to provide robust and credible information. The strength of this
study is that CCCS is a highly centralized system. The attributes of CCCS are consistent, with a credible target population of students who reflect the contemporary collegiate population identified and described in the literature review.

Common course numbering, a statewide curriculum committee, consistent student learning outcomes, and guaranteed transfers are centralized constructs that justify using aggregated CCCS data to explore and test the hypothesis presented in this research study. It is for this reason that the “system” is presented for analysis and discussion versus individual Colorado community colleges. Individual college assessments may only be appropriate when attempting to implement policy versus a global “system” policy assessment.

**Analytic Model**

One characteristic of RDD analysis is local randomization (Calcagno & Long, 2008). This study is based on the idea that observed differences between students who just miss and just make the Accuplacer® assessment cut-score are random. The analytics of this model compare the mean outcomes for students just to the left and just to the right of the cut-point. This methodology follows the prescribed checklist for researchers conducting a retrospective RDD analysis as offered by Jacob, Zhu, Somers, and Bloom (2012).

The literature review provides the relevant information regarding the process for assigning the ratings and how the cut score was determined. The methodology, therefore, commences with graphical analysis that plots the probability of receiving remediation as a function of the Accuplacer® assessment. The graphical presentations provide a visual assessment of whether or not there is evidence of a valid RDD. The design is identified
as a type II fuzzy RDD—one in which some treatment group members (no-shows) do not receive treatment and some comparison groups (cross-overs) do receive treatment and (Battistin & Rettore, 2008).

A mathematical equation is applied to validate that the Accuplacer® cut score is highly correlated with remediation and independent of the error term. The mathematical equation is as follows:

\[ T = \beta_0 + \beta_1 X + \beta_2 \text{Accuplacer® Score} + \beta_3 \text{ACARHIGH} + \epsilon \]

Because of the large CCCS dataset, a nonparametric approach is utilized to identify an appropriate bandwidth, (i.e., a subset), that is established to conclude the examination.

**The nonparametric/local strategy.** A nonparametric approach views the estimation of treatment effects as local randomization and limits the analysis to observations that lie within the close vicinity of the cut-point (sometimes called a bandwidth or neighborhood), where the functional form is more likely to be close to linear (Jacob et al.). The challenge lies in selecting the appropriate bandwidth. A larger bandwidth will yield more precise estimates, because more data points will be used in the regression, but the potential for bias is also larger when estimating the treatment effect.

The most commonly used nonparametric regression analysis for RDDs—a local linear regression—searches for the optimal data range within which a simple linear regression will produce a consistent estimate (Jacob et al., 2012). A series of local linear regressions provide a non-parametric approach for estimating the treatment effect in an RDD (Hahn, Todd & van de Klaauw, 2001; Porter, 2003). Following Imbens and Lemieux (2008), this study estimates a standard regression over a window of width \( h \) on both sides of the cutoff point. The results are presented graphically.
A local linear regression can be thought of as estimating a linear regression on the two bins adjacent to the cut-point, allowing the slope and intercept to differ on either side of the cut-point. The regression model on the left hand side of the cutoff point is

\[ Y = a_l + b_l \cdot (X - c) + e, \text{ where } c-h \leq X < c \]

while the regression model on the right hand side of the cutoff point is

\[ Y = a_r + b_r \cdot (X-c) + e, \text{ where } c \leq X \leq c + h \]

This non-parametric strategy substantially reduces the chance that bias is introduced; however, the statistical power is limited due to the smaller subset to be analyzed (Jacob et al.).

A linear regression is also applied on all of the covariates, ensuring that the model addresses all of the principles of a valid RDD design. The RDD must meet a variety of conditions to provide unbiased impact estimates and to approach the rigor of a randomized experiment (Hahn et al., 2001; Shadish, Cook, & Campbell, 2002). Specifically, Jacob et al., (2012) prescribed the following:

\(\text{1) The rating variable cannot be caused by or influenced by the treatment. The rating variable is measured prior to the start of treatment or is a variable that can never change.}\)

\(\text{2) The cut-point is determined independently of the rating variable (that is, it is exogenous), and assignment to treatment is entirely based on the candidate ratings and the cut-point.}\)

\(\text{3) Nothing other than treatment status is discontinuous in the analysis interval (that is, there are no other relevant ways in which observations on one side of the cut-point are treated differently from}\)
(4) The functional form representing the relationship between the rating variable and the outcome, which is included in the estimation model, is continuous throughout the analysis interval absent the treatment and is specified correctly. (p. 7)

Once the bandwidth is identified, a two-stage least square regression is applied to perform the estimates on the subset in order to conduct the analysis necessary to offer an answer to the research question. The two-stage least square mathematical equation is as follows:

First-stage equation:

\[ T = \beta_0 + \beta_1X + \beta_2X + \beta_3 \text{Score} + \beta_4 \text{Below} + \varepsilon \]

Second-stage equation:

\[ Y = \alpha_0 + \alpha_1X + \alpha_2X + \alpha_3 \text{Score} + \alpha_3 \text{Treatment}^\wedge + \mu \]

where:

- \( T \) = Probability of remediation
- \( Y \) = Transfer to a four-year institution
- \( \beta_1X \) = Various demographics related to the heterogeneous nature of community college students
- \( \beta_2X \) = College algebra, gateway predictor course for transfer, seeking transfer, and undecided
- \( \beta_3 \) = Accuplacer® assessment score
- \( \beta_4 \text{Below} \) = 0 if student is assigned to remediation based on the cut-score rule, and 1 otherwise. The descriptor is identified as “ACARHIGH”.
\( \varepsilon \) = random error in first stage regression, assumed to be identically and independently distributed

\( \mu \) = random error in second stage regression, assumed to be identically and independently distributed

The student data for this study were collected, consolidated, and provided by the Office of Institutional Research at the CCCS office, utilizing both private internal data and public data from The National Student Clearinghouse®. The NSC provided the student transfer information. The collective information constitutes the dataset used in this study and is specific to CCCS students who enrolled at the institution for the first time in fall 2009 and fall 2010. The data were aggregated into one record per student. The total dataset exceeded 11,600 student records. The student information utilized from those who enrolled in 2009 and 2010 is the most complete information available from both CCCS and the National Student Clearinghouse®.

The NSC is a reliable resource for education verification and student educational outcomes research. Founded in 1993 by the higher education community, the National Student Clearinghouse® relieves the administrative burdens and costs related to student data reporting and exchange. The NSC is a 501(c)(6) nonprofit and nongovernmental organization and the leading provider of educational reporting, data exchange, verification, and research services. More than 3,600 colleges and universities participate in the Clearinghouse, reporting enrollment and degree information to its members regularly throughout the year. Participants enroll 98% of all students in public and private U.S. institutions (National Student Clearinghouse®, 2014). CCCS is a system made up of 13 community colleges and as such, a system participant that provides access
to actual enrollment and degree information regarding all CCCS students to the
Clearinghouse.

The dataset provides a robust set of quantitative variables consistent with the
global characteristics of community colleges and characteristics of the student bodies of
the community colleges. The American Association of Community Colleges (2014) and
the National Center for Public Policy and Higher Education (2011) described the
community college students as primarily low income, first-generation, the first in their
families to go to college, and from underrepresented racial or ethnic groups. Community
colleges provide access to education for many nontraditional students, such as adults who
are working while enrolled. The average age of a community college student is 29, and
two-thirds of community college students attend part-time. Half are women. Community
colleges are not only providing access for adult students, but are also serving an
increasingly significant number of traditional age and high school students who take
specific courses to get ahead in their studies (AACC, 2014). An explanation of the
variables used in this study follows:

1. TRANSFERRED_IND – Student transferred to any school after attending a
   CCCS institution.

2. AGE_NT – Student was over age 24 when first matriculated at a CCCS
   institution.

3. FG_IND – Student self-reported first generation status on application to a
   CCCS institution.

4. MALE_IND – Student self-reported male on application to a CCCS
   institution.
5. **HISPLAT_IND** – Student self-reported race or ethnicity was of Hispanic or Latino origin.

6. **BLACK_IND** – Student self-reported Black ethnicity.

7. **ASIAN_IND** – Student self-reported Asian ethnicity.

8. **AMIND_IND** – Student self-reported American Indian ethnicity.

9. **SEEKTRANS_IND** – Student declared a transferrable degree as his/her major (AA, AGS, AS).

10. **UNDNDS_IND** – Student was undeclared or non-degree-seeking during his/her first term at a CCCS institution.

11. **REMED_MAT_ENROLLED_IND** – Student at any time was enrolled in remedial math.

12. **MAT121_PASS_IND** – Student at any time passed MAT121.

13. **ACAR** – Student’s raw score on the Accuplacer® arithmetic test.

14. **ACARHIGH** - Accuplacer® arithmetic score above and below the cut score.

Table 3.2 presents the descriptive statistics of the entire CCCS student dataset utilized to identify and develop the subset of the RDD study. This data reports that 62% of the students scored less than 85 on the Accuplacer® arithmetic assessment, 64% enrolled in remediation, 10% completed college algebra, and 24% transferred to a four-year institution.
Table 3.2.

Descriptive Statistics of the Total CCCS Student Dataset

<table>
<thead>
<tr>
<th>Description</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferred to a four-year institution</td>
<td>11647</td>
<td>.24</td>
<td>.43</td>
</tr>
<tr>
<td>Over Age 24 when matriculated into CCCS</td>
<td>11647</td>
<td>.47</td>
<td>.50</td>
</tr>
<tr>
<td>First Generation</td>
<td>11647</td>
<td>.60</td>
<td>.49</td>
</tr>
<tr>
<td>Male</td>
<td>11647</td>
<td>.50</td>
<td>.50</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>11647</td>
<td>.18</td>
<td>.39</td>
</tr>
<tr>
<td>Black</td>
<td>11647</td>
<td>.10</td>
<td>.30</td>
</tr>
<tr>
<td>Asian</td>
<td>11647</td>
<td>.04</td>
<td>.18</td>
</tr>
<tr>
<td>American Indian</td>
<td>11647</td>
<td>.02</td>
<td>.15</td>
</tr>
<tr>
<td>Student declared a transferable degree</td>
<td>11647</td>
<td>.50</td>
<td>.50</td>
</tr>
<tr>
<td>Student non-degree seeking</td>
<td>11647</td>
<td>.11</td>
<td>.31</td>
</tr>
<tr>
<td>Accuplacer® assessment score</td>
<td>11647</td>
<td>62.16</td>
<td>28.59</td>
</tr>
<tr>
<td>Enrolled in a math remediation class</td>
<td>11647</td>
<td>.64</td>
<td>.48</td>
</tr>
<tr>
<td>Passed Math 121–college algebra</td>
<td>11647</td>
<td>.10</td>
<td>.30</td>
</tr>
</tbody>
</table>

Calcagno and Long (2008) suggested that a RDD does not require additional vectors of control. However, because of the heterogeneous nature of the community college student, the CCCS student demographics are included in the estimation. Lee (2008) suggested that adding a set of covariates essentially has no impact on RDD estimates. Nor does including them have a large impact on the standard errors. The main advantage of using baseline covariates is to help establish the validity of the RDD, as opposed to improving the efficiency of the estimators.

The successful completion of college algebra is included in the regressions, given the challenges and barriers presented in the literature review between remediation and this most important gateway course. The student demographics include whether the student is over age 24 when he or she matriculated into the CCCS, if the students are first generation, their gender, and their race. The information derived from these coefficients
is used to corroborate previous research regarding the uniqueness of the community college student and to identify opportunities specific to the subset of CCCS students.

The analysis of dichotomies includes the following: transfer (to a four-year institution), age of students (24 years or older), and first generation. The composite gender of students is transformed into male and female; female is the reference group. Likewise, race is transformed into Hispanic, Black, Asian, American Indian, and White: White is the reference group. Age is transformed into over age 24 when first matriculated at a CCCS institution, and traditional age 18 through 24: traditional is the reference group. Other dichotomies for consideration include whether the students enrolled in a remedial math class and whether college algebra was successfully completed. Graphical presentations of these covariates and empirical analysis is presented to further confirm the validity of the RDD utilized in this study.

The SDT provides the rationale for including the educational outcome variable (completion of college algebra). Figure 3.2 provides the application of the SDT to this analytical model. A graphical presentation of this educational outcome is also presented for analysis in Figure 4.13. Regardless of an Accuplacer® arithmetic assessment, a student’s self-efficacy is the basis for intrinsic motivation, personality integration, and the conditions that foster positive processes (Ryan & Deci, 2000). Ryan and Deci (2000) identified three innate needs that, if satisfied, allowed for optimal function and growth: (a) competence, (b) autonomy, and (c) relatedness. Hadden et al. (2013) stated, “taken together, SDT posits that all three are necessary for optimal functioning, and fulfillment
arises out of the interaction between the person’s needs and the environmental context” (p. 275).

**Figure 3.2.** Application of the SDT to the Analytic Model

**Summary**

This chapter establishes the research design for this study and the appropriateness of the self-determination theory when considering one single assessment of college readiness. The following chapter presents results and findings of the data collected and conclusion chapters of this study addresses the research question and considers the consequences of measuring a student’s academic preparedness and college readiness to an Accuplacer® Arithmetic Assessment cut score.
CHAPTER 4
RESULTS AND DISCUSSION

Graphic Presentation

A major advantage of the RDD over competing methods is its transparency, which can be illustrated using graphical methods (Lee & Lemieux, 2009). Therefore, the results and discussion section of this study begins with a graphic presentation intended to provide the visual assessment of discontinuity in transfer based on the treatment (remediation) as the result of the Accuplacer® arithmetic assessment cut-score of 85.

Figure 4.1 depicts the total CCCS data set and illustrates the raw Accuplacer® scores (X) against the probability of remediation (Y).

Figure 4.1. Probability of Remediation Based Upon Accuplacer® Scores

This graph illustrates curves of best fit for the percent of students remediated at each Accuplacer score. The blue curve, for below the cut scores, is a linear regression with R-
squared = 0.66. The red curve, for above the cut scores, is a polynomial (order 2) regression, AKA quadratic regression, with R-squared = 0.78. Several different curves were tried. This assessment was selected purely on R-squared as a measure of goodness of fit. A clear discontinuity is identified at the cut point of Accuplacer = 85. All CCCS students are included in the illustration.

**Validating Casual Interference**

A RDD is considered legitimate if a valid casual interference can be made for the sample that is being observed (Shadish, Cook, & Campbell, 2002). The 19th-century philosopher, John Stuart Mill, formalized the relationship between cause and effect by characterizing the phenomenon as follows: (1) the cause precedes the effect, (2) the cause is related to the effect, and (3) there is no plausible alternative explanation for the effect other than the cause (Shadish et al., 2002). For students who scored less than 85, there is statistical significance (p = .00) by a factor of .12 that the Accuplacer® arithmetic assessment identified the need for remediation. The correlation between the Accuplacer® assessment and remediation appears to be adequate. However, the correlations are lessened because student level factors such as attendance, drop out, motivation, and perseverance have great effects on the need for remediation, and once again, the Accuplacer® does not consider these factors (Scott-Clayton, 2012). Table 4.1 reflects the statistical results of causality used to validate this model.
Table 4.1.

**Test for Validity of Regression Discontinuity Model**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$</th>
<th>$SD\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over Age 24 when matriculated into CCCS</td>
<td>.02</td>
<td>.02</td>
<td>.28</td>
</tr>
<tr>
<td>First Generation</td>
<td>.03</td>
<td>.02</td>
<td>.17</td>
</tr>
<tr>
<td>Male</td>
<td>.02</td>
<td>.02</td>
<td>.25</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>-.02</td>
<td>.03</td>
<td>.56</td>
</tr>
<tr>
<td>Black</td>
<td>.03</td>
<td>.04</td>
<td>.50</td>
</tr>
<tr>
<td>Asian</td>
<td>-.06</td>
<td>.02</td>
<td>.26</td>
</tr>
<tr>
<td>American Indian</td>
<td>.08</td>
<td>.07</td>
<td>.24</td>
</tr>
<tr>
<td>Student declared a transferrable degree</td>
<td>.14</td>
<td>.02</td>
<td>.00</td>
</tr>
<tr>
<td>Student is non-degree seeking</td>
<td>-.10</td>
<td>.03</td>
<td>.01</td>
</tr>
<tr>
<td>Accuplacer® assessment score</td>
<td>-.00</td>
<td>.00</td>
<td>.63</td>
</tr>
<tr>
<td>Above/below the cutoff</td>
<td>-.12</td>
<td>.04</td>
<td>.00</td>
</tr>
<tr>
<td>Passed Math121-college algebra</td>
<td>.08</td>
<td>.03</td>
<td>.03</td>
</tr>
</tbody>
</table>

Dependent Variable = Enrolled in math remediation  
$p = .05$

Lee and Lemieux (2010) reported, “If individuals—even while having some influence—are unable to precisely manipulate the assignment variable, a consequence of this is that the variation in treatment near the threshold is randomized as though from a randomized experiment” (p. 285). There is concern that retesting practices may not be standard across all of the colleges. As a result, the ability to retake the Accuplacer® Arithmetic Assessment could threaten the validity of the assessment as a tool for accurate placement. This is a crucial feature of the RDD, since it is the reason RDD is often so compelling.

Therefore, a histogram was developed for further analysis. Figure 4.2 suggests that the CCCS students do not appear to engage in retesting to the extent that RDD assumptions are violated. It appears that CCCS students are not able to influence the
Accuplacer® arithmetic assessment scores and, as such, the treatment is indeed randomly assigned around the cutoff.

![Histogram of CCCS Accuplacer® Placement Scores (2009 and 2010)](image)

**Figure 4.2.** Histogram of CCCS Accuplacer® Placement Scores (2009 and 2010)

**The Optimal Bandwidth**

Choosing a bandwidth in a nonparametric estimation involves finding the optimal balance between precision and bias (Jacob et al., 2012). In this study, a bandwidth of nine is identified, by first visually examining the distribution of the rating variable, and then by estimating a local linear regression for each coefficient. This process involves using observations within the bandwidth on either side of the cut-score. This procedure is utilized to reduce any boundary issues (Hahn et al., 2001) and to produce a consistent estimate. Imbens and Lemieux (2008) also endorse this nonparametric approach to estimate RDD impacts.

The estimates begin with an assessment of the proportion of students transferring predicated on the Accuplacer® (ACAR) assessment score. Figure 4.3 illustrates the results. All other coefficients are assessed and illustrated in Figures 4.4 through 4.19. All estimates validate the appropriateness of using a bandwidth of nine.
Figure 4.3. Density of Transfer Based Upon Accuplacer® Scores - Bandwidth of Nine

Figures 4.4 through 4.12 illustrate the Accuplacer® assessment (ACAR) distribution by a variety of student demographics within the bandwidth of nine. The small size of the bandwidth sample did not lend itself to a higher order regression, but does illustrate the shape of the distribution and validates the design.

Figure 4.4. Non-traditional Age Students  Figure 4.5. Male Students
Figure 4.6. First Generation Students
Figure 4.7. Hispanic Students
Figure 4.8. Black Students
Figure 4.9. American Indian Students
Figure 4.10. Asian Students
Figure 4.11. Students Planning to Transfer
Figure 4.12. Students Undecided
Figures 4.13 illustrate educational outcomes (completion of college algebra) by the Accuplacer® assessment (ACAR). Each graph corresponds to a different educational outcome. The circles are the mean of the binary dependent variable for students with a given Accuplacer® score. The fitted lines are predicted probabilities from a linear probability model for the education outcome on the assignment to remediation.

![Graph showing ACAR Raw Score vs Proportion of Students Enrolled in MAT121](image)

**Figure 4.13.** Successful Completion of MAT121

Further graphical assessments offer additional confirmation that the design is valid. Figures 4.14 and 4.15 illustrate the frequency of each Accuplacer® score and the frequency of remediation for each Accuplacer® score within the band.

![Graph showing Frequency of Score](image)  ![Graph showing Frequency of Remediation](image)

**Figure 4.14.** Frequency of Score  **Figure 4.15.** Frequency of Remediation
Table 4.2 presents the results of the local linear regressions and the statistical significance of each coefficient, as well as the predictor variable-the Accuplacer® (ACAR) score.

Table 4.2.

*Results of Local Linear Regressions Performed on All Coefficients.*

<table>
<thead>
<tr>
<th>Description</th>
<th>Below</th>
<th></th>
<th></th>
<th>Above</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
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<td>$p$</td>
<td>$\beta$</td>
<td>SE $\beta$</td>
<td>$p$</td>
</tr>
<tr>
<td>Transfer</td>
<td>.74</td>
<td>.40</td>
<td>.07</td>
<td>.05</td>
<td>.43</td>
<td>.90</td>
</tr>
<tr>
<td>ACAR</td>
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<td>.01</td>
<td>.25</td>
<td>.00</td>
<td>.01</td>
<td>.58</td>
</tr>
<tr>
<td>Pass MAT121</td>
<td>-.33</td>
<td>.30</td>
<td>.26</td>
<td>.18</td>
<td>.33</td>
<td>.59</td>
</tr>
<tr>
<td>ACAR</td>
<td>.01</td>
<td>.00</td>
<td>.12</td>
<td>.00</td>
<td>.00</td>
<td>.92</td>
</tr>
<tr>
<td>Seek Transfer</td>
<td>.61</td>
<td>.45</td>
<td>.18</td>
<td>-.10</td>
<td>.47</td>
<td>.83</td>
</tr>
<tr>
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<td>.85</td>
<td>.01</td>
<td>.01</td>
<td>.18</td>
</tr>
<tr>
<td>Undecided</td>
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<td>.29</td>
<td>.54</td>
<td>.21</td>
<td>.31</td>
<td>.49</td>
</tr>
<tr>
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<td>.00</td>
<td>.31</td>
<td>-.00</td>
<td>.00</td>
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</tr>
<tr>
<td>First Generation</td>
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<td>.70</td>
<td>.89</td>
<td>.47</td>
<td>.06</td>
</tr>
<tr>
<td>ACAR</td>
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<td>.35</td>
<td>-.00</td>
<td>.01</td>
<td>.47</td>
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<td>.48</td>
<td>.02</td>
<td>-.32</td>
<td>.46</td>
<td>.49</td>
</tr>
<tr>
<td>ACAR</td>
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<td>.00</td>
<td>.01</td>
<td>.01</td>
<td>.05</td>
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<tr>
<td>Hispanic</td>
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<td>.31</td>
<td>.59</td>
<td>.37</td>
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<td>.26</td>
</tr>
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<td>ACAR</td>
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<td>.00</td>
<td>.93</td>
<td>-.00</td>
<td>.00</td>
<td>.48</td>
</tr>
<tr>
<td>Black</td>
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<td>.25</td>
<td>.18</td>
<td>.15</td>
<td>.24</td>
<td>.54</td>
</tr>
<tr>
<td>ACAR</td>
<td>-.00</td>
<td>.00</td>
<td>.31</td>
<td>-.00</td>
<td>.00</td>
<td>.48</td>
</tr>
<tr>
<td>American Indian</td>
<td>-.16</td>
<td>.14</td>
<td>.27</td>
<td>-.08</td>
<td>.13</td>
<td>.52</td>
</tr>
<tr>
<td>ACAR</td>
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<td>.20</td>
<td>.00</td>
<td>.00</td>
<td>.43</td>
</tr>
<tr>
<td>Asian</td>
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<td>-.18</td>
<td>.73</td>
<td>-.12</td>
<td>.18</td>
<td>.50</td>
</tr>
<tr>
<td>ACAR</td>
<td>.00</td>
<td>.00</td>
<td>.57</td>
<td>.00</td>
<td>.00</td>
<td>.38</td>
</tr>
</tbody>
</table>

$p = .05$

$N = 2175$
Accordingly, Table 4.3 reflects the descriptive statistics for this subset - a largely heterogeneous population of students, consistent with typical community colleges (Elmogahzy, 2014). The subset is reduced to $N = 2175$. Of this subset of CCCS students, 50% scored less than 85 on the Accuplacer® arithmetic assessment, 63% enrolled in a math remediation, 13% completed college algebra (MAT121), and 28% transferred to a four-year institution.

Table 4.3.

*Descriptive Statistics of CCCS Student Subset – Bandwidth of Nine*

<table>
<thead>
<tr>
<th>Descriptive</th>
<th>$N$</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferred to a four-year Institution</td>
<td>2175</td>
<td>.28</td>
<td>.45</td>
</tr>
<tr>
<td>Over Age 24 when matriculated into CCCS</td>
<td>2175</td>
<td>.47</td>
<td>.50</td>
</tr>
<tr>
<td>First Generation</td>
<td>2175</td>
<td>.57</td>
<td>.50</td>
</tr>
<tr>
<td>Male</td>
<td>2175</td>
<td>.57</td>
<td>.50</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>2175</td>
<td>.14</td>
<td>.35</td>
</tr>
<tr>
<td>Black</td>
<td>2175</td>
<td>.08</td>
<td>.27</td>
</tr>
<tr>
<td>Asian</td>
<td>2175</td>
<td>.04</td>
<td>.19</td>
</tr>
<tr>
<td>American Indian</td>
<td>2175</td>
<td>.02</td>
<td>.15</td>
</tr>
<tr>
<td>Student declared a transferrable degree</td>
<td>2175</td>
<td>.52</td>
<td>.50</td>
</tr>
<tr>
<td>Student is non-degree seeking</td>
<td>2175</td>
<td>.12</td>
<td>.32</td>
</tr>
<tr>
<td>Accuplacer® Assessment Score</td>
<td>2175</td>
<td>85.00</td>
<td>5.50</td>
</tr>
<tr>
<td>Above/Below the Cutoff</td>
<td>2175</td>
<td>.50</td>
<td>.50</td>
</tr>
<tr>
<td>Enrolled in math remediation class</td>
<td>2175</td>
<td>.63</td>
<td>.48</td>
</tr>
<tr>
<td>Passed Math121-college algebra</td>
<td>2175</td>
<td>.13</td>
<td>.34</td>
</tr>
</tbody>
</table>

**Regression Discontinuity**

Finally, Figure 4.16 assesses the frequency distribution of the Accuplacer® scores against the probability of transfer.
Figure 4.16. Probability of Transfer Based Upon Accuplacer® Scores

This graph shows curves of best fit for the percent of students transferring to a 4-year institution at each Accuplacer® score. The blue curve, for below the cut scores, is a linear regression with R-squared = 0.72. The red curve, for above the cut scores, is a linear regression with R-squared = 0.64. Several different curves are applied and are selected purely on R-squared as a measure of goodness of fit. A clear discontinuity can be seen at the cut point of Accuplacer® = 85. All CCCS students are again included in this illustration. The results of the analysis suggest that remediation has a low likelihood of affecting the transfer to a four-year institution (p = .50) by a factor of -0.22. Table 4.4 reflects the results of equation.
### Table 4.4.

**Regression Results Affecting Transfer**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$</th>
<th>$SD \beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over Age 24 when matriculated into CCCS</td>
<td>-.07</td>
<td>.02</td>
<td>.00</td>
</tr>
<tr>
<td>First Generation</td>
<td>-.02</td>
<td>.02</td>
<td>.26</td>
</tr>
<tr>
<td>Male</td>
<td>-.05</td>
<td>.02</td>
<td>.03</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>-.01</td>
<td>.03</td>
<td>.62</td>
</tr>
<tr>
<td>Black</td>
<td>.13</td>
<td>.04</td>
<td>.00</td>
</tr>
<tr>
<td>Asian</td>
<td>-.03</td>
<td>.05</td>
<td>.59</td>
</tr>
<tr>
<td>American Indian</td>
<td>-.08</td>
<td>.07</td>
<td>.29</td>
</tr>
<tr>
<td>Student declared a transferrable degree</td>
<td>.07</td>
<td>.05</td>
<td>.15</td>
</tr>
<tr>
<td>Student is non-degree seeking</td>
<td>.11</td>
<td>.05</td>
<td>.01</td>
</tr>
<tr>
<td>Accuplacer® Assessment Score</td>
<td>-.00</td>
<td>.00</td>
<td>.75</td>
</tr>
<tr>
<td>Enrolled in math remediation class</td>
<td>-.22</td>
<td>.33</td>
<td>.50</td>
</tr>
<tr>
<td>Passed Math121-college algebra</td>
<td>.29</td>
<td>.04</td>
<td>.00</td>
</tr>
</tbody>
</table>

Dependent Variable = Transfer
Instrument Variable = ACARHIGH

$p = .05$

$R^2 = .08$

$N = 2175$

 Academically prepared students assigned to remediation may garner little or no educational benefit, but incur additional tuition and time costs and may be discouraged from or delayed in their transfer plans (Mantorell & McFarlin, 2011). Using regression-discontinuity (RDD) analysis to compare students just above and just below remedial test-score cutoffs, this study contributes to several studies that also found null to negative impacts of remediation for “marginal” students (Calcagno & Long, 2008; Martorell & McFarlin, 2011; Scott-Clayton, & Rodriguez, 2012). As in this study, Lee and Lemieux (2010) suggested that it is not an assessment score, but random variation that determines which students fall just below and just above a cut point.

Bracco (2014) recognized that the greatest placement errors are likely to occur when students fall close to the cut score. Accordingly, even the Accuplacer® test
publishers themselves emphasize that test scores should not be used as the sole factor in placement decisions (Scott-Clayton et al., 2014). Best practice, therefore, could include using an “academic preparedness” assessment in conjunction with other indicators of “college readiness.” The graph presented (Figure 4.1) suggests there may be other variables to consider when assessing a student for college readiness. It may be that the Accuplacer® assessment does not matter as much as how the student feels about himself or herself, that is, students are enrolling in remedial math classes regardless of their assessment score.

Successful completion of college algebra is expected of students who scored at or above the cut score of 85. However, there were students below the cut score who were able to successfully complete college level math. Of the 204 students in this bandwidth who passed college algebra, 104 students (51%) had a placement score less than 85. One could infer that students who are intrinsically motivated to concentrate and try extra hard might be especially prevalent (Jacob et al., 2012). This assessment is consistent with the self-determination theory. However, alternative reasoning might suggest that the CCCS cut score may be simply too low.

There are also students enrolled in remedial math in spite of an assessment score of 85 or better. Of the 1,381 students enrolled in a math remediation class, 619 students (28%) enrolled in remediation even though they were deemed to be college ready. It is possible that there are students who enroll in college algebra only to discover their mathematic competencies are inadequate and consequentially enroll in a remedial math course to improve their skill set. This also suggests that students who are intrinsically motivated to concentrate and try extra hard might be especially prevalent, or the CCCS
cut score may be too high. Lee (2008) offered an interpretation for these scenarios suggesting that ratings by decision makers and candidates are typically imprecise. Phipps (1998) added that the score identifying college readiness is arbitrary.

The performance of the CCCS students in this study contributes to the literature and supports the notion that college algebra is a gatekeeper course for degree completion (Reyes, 2010). The fact that passing college algebra reflects a high likelihood ($\beta = .30$) of affecting transfer ($p = .00$) indicates the important role the successful completion of college algebra plays in preparing students for transfer. The students who pass college algebra, in spite of scoring below 85, may be driven by the SDT to overcome the lack of prescribed college readiness to persist and transfer. Accordingly, Mullin (2012) concluded “students who show the drive to transfer show an intention to complete that other students might lack” (p. 5).

To achieve success in college, students need more than just academic skills. They must adapt to new expectations, learning styles, professors, and surroundings. They must learn to collaborate with new students, and satisfy college course and graduation requirements. For most CCCS community college students, these new responsibilities can be overwhelming because many students lack the essential non-academic skills necessary to tackle college challenges. In fact, even students deemed to be academically college-ready, through test scores or the completion of developmental coursework, often fail to persist and transfer - regardless of gender, age, race, or socio-economic status. The research of Mullen (2012) suggested that students who start at a community college generally display fewer characteristics that are associated with a high likelihood of transferring than students who start at a four-year institution. Regardless of a student’s
demographics, these variables offer important alternative explanations for the relationship between remediation and transfer production. The statistically significant probability of non-traditional \((p = .00)\), male \((p = .03)\), and black students \((p = .00)\) transferring to a four year institution contributes to the prior research.

The coefficient of determination \((R^2)\) is such that \(0 \leq r^2 \leq 1\), and, particular to this study, denotes the strength of the linear association between transfer and remediation and the other independent variables utilized. Only 8% of the total variation in transfer is explained by the constructs in the model. This further implies that there is much unknown about the student’s intrinsic motivation, behavior, and attitude at the time of completion of the Accuplacer® arithmetic test. This is not information collected by the colleges when a student applies and as such, again suggests that a single assessment may not be the most effective in determining the college readiness of CCCS students. Exploration of unknown behaviors of the CCCS student warrants further research separate from this study.

Although it is most probable that students may be allowed to retest the Accuplacer® assessment in order to avoid remediation and that they may know the cut score, Lee and Lemieux (2010) suggested that students cannot fully determine their scores on the placement assessment because of random testing error. They further suggested that imprecise control over rating is sufficient to produce random assignment at the cut score, which yields a valid RDD–as long as the cut score has been determined without knowledge of the student’s scores.
Summary

The results described in this chapter indicate that for community college students on the margin of the Accuplacer® assessment cut-score, math remediation is not likely to affect the transfer to a four-year institution. The ambiguity of the CCCS basic skills policy appears to lend itself to a suggestion rather than a rule. As such, the randomness of assignment to remediation is questionable. Therefore, the appropriateness of the prescribed treatment (remediation) and support for student success (i.e., transfer) must be reassessed if CCCS students are expected to persist. The self-determination theory contributes to the results by suggesting that it is not the assessment score, but how the students feel about themselves that is paramount. The implications of these findings, conclusions derived from them, and subsequent possible policy considerations are addressed in the final chapter of this dissertation.
CHAPTER 5

CONCLUSION

Institutional intent and actions must be purposeful in order to foster transfer and student success. However, even the most thoughtful and well-intentioned policies will be limited in their effectiveness if they fail to address the critical issues that reflect the real life circumstances and constraints confronting students seeking to transfer. Policy makers involved in higher education in Colorado are being challenged to respond to House Bill 14-1319 and new funding criteria for student success. Colorado legislation now promotes a performance based funding model that champions improved certificate and degree completion, improvement in the number of “on-time” completions, and improvement in the number of students successfully transferring from community colleges to four-year universities (Colorado Commission on Higher Education, 2013).

House Bill 14-1319 represents a significant change in how the State of Colorado funds higher education. Previously, funding for institutions was based on historical allocations and available funds rather than specific state policy goals. House Bill 14-1319 requires that the allocation of state funding is based on common, measurable, and updatable factors and metrics. Figure 5.1 illustrates the performance measures identified in the new legislation.
Although performance based funding is not a singular solution for improving college completion and transfer rates, Complete College American (2014) concluded that it must be in place to make other reforms and practices effective. Complete College America is a national non-profit that works with states to increase the number of Americans with quality career certificates or college degrees and to close attainment gaps for traditionally underrepresented populations. Performance based funding promises to challenge Colorado community colleges’ decision makers to think beyond access and affordability to how remediation affects the likelihood that students will persist and transfer to four-year institutions. Figure 5.2 illustrates the direction higher education in Colorado is headed in today’s political environment.
Policy Considerations

The literature suggested that institutional placement policies serve as barriers to enrollment in college-level classes (Marwick, 2010). This study contributes to the literature by suggesting that the barrier is indeed placement policies, not the treatment that may result from the assessment scores. When community college policies prescribe necessary remedial instruction, they can be crucial to student success (Rouche & Rouche, 1999). However, when institutional placement policies prevent students from enrolling in courses in which they could be successful, the politics often deny access to the instruction that students need to persist, complete, and transfer.

If institutions allocate opportunity based on test scores that do not adequately reflect the skills needed for course success, the mission of a community college to provide access to college-level courses for all is threatened (Marwick, 2010). Marwick (2010) also suggested that such policies are particularly harmful to low-income and minority students who often constitute the majority of students placed in remedial or developmental courses. Parnell (1995) recommended that community college efforts focus on excellence for all students, not simply the labeling and sorting of students.
This study explores the effectiveness of using the Accuplacer® assessment cut-score when assessing college readiness and confirms that the predictability and accuracy of this assessment is not optimal. High-stakes placement exams are proven poor predictors of college readiness, unnecessarily sending thousands of students into remediation each year (Conley, 2007). This study supports Conley’s conclusion and proves to be especially applicable for those CCCS students on the margin of the Accuplacer® cut-off score. Remediation, in and of itself, had no effect on transfer.

Marwick (2010) argued that the importance of institutional placement policies in determining academic success and goal achievement challenges those involved to find a better solution to this complicated problem. It may be that other measures of academic preparedness, alone or in concert with the placement test score, would be better predictors of academic success than a single test score for students served in the Colorado Community College System. Although Colorado, as well as many other states, currently relies on a single standardized test to determine course placement, the evidence is mounting for the need to update these policies and the related cut-scores (Bracco, 2014). CDHE has not updated its policy since 2004.

This study furthermore supports the conclusions of Wattenbarger and McLeod (1989) that a combination of several factors may provide a more successful placement policy than consideration of a test score alone. However, the ACT® or SAT® may not be the best alternatives. This study provides evidence that a single Accuplacer® assessment score may lead to students being over-placed into remediation. The CCCS subset identified students whose Accuplacer® assessment were below the cut-score; but in spite of such a placement score, these students achieved academic outcomes that were
equal to or better than the outcomes of students who placed at or above the cuts score and successfully passed college algebra. Remediation is superfluous as a prescribed treatment.

The CCCS data also identifies students whose Accuplacer® assessment placed them at or above the cut-score, but regardless, they enrolled in remedial math. Accordingly, Complete College America (2014) has suggested that colleges consider using a placement range to start most underprepared students in college-level courses with co-requisite academic support, within which 75% or more of those students can succeed. In essence, community colleges might consider establishing two cut-scores: one that provides direct entry into standard college courses and another that signals very low level of readiness for college work, even with co-requisite assistance.

There is no argument that academic preparation for college is essential. However, a single assessment used to measure college readiness is not appropriate, and remediation may not be the most effective treatment offered to ensure CCCS student success (i.e., transfer) as indicated in this study. CCCS decision makers may want to consider expanding Board Policy 9-41 to include multiple measures that may provide a more complete understanding of student ability. The “whole student” is complex, and the factors contributing to student success are multi-faceted. The notion that it is not so much the assessment score, but how students feels about themselves is worth further consideration.

The Accuplacer® arithmetic assessment may be a calibrated indicator of college readiness for community college students; however, it may not delineate a set of skills students need to be successful as they endeavor to transfer to four-year institutions.
Barnes, Slate, and Rojas-LeBouef (2010) recommended that further consideration be given to the distinction between the term college-readiness and academic preparedness. Barnes et al., (2010) presented evidence that college-readiness, as defined, does not represent the set of skills students need to be successful in college. Conley (2007) contributed that college readiness is a complex concept that integrates cognitive, non-cognitive, and social cognitive factors.

Specific content knowledge, or lack thereof, may result in the need for remediation without regard for a measurement of knowledge of academic strategies for reading, writing, or critical thinking (Conley, 2007). An assessment that captures a range of information, including student’s non-cognitive and social cognitive skills (e.g., study skills, persistence, test taking, motivation, and determination) could provide important information to be used for placement decisions and a more accurate measurement of students’ current readiness for college. Multiple measures could provide an assessment of the complex community college student that includes such constructs as additional test scores, high school grade point average, assessments that measure life experiences, and student advisors’ input and referrals.

Community college advisors typically have large caseloads and a limited amount of time per student consultation, and CCCS advisors are no different. This is both a challenge and an opportunity that must be addressed. CCCS colleges would need to determine how to budget for a more robust assessment. In addition, CCCS student advisors would need to rethink how to use their limited time to take into account more complex student profiles if multiple assessments are implemented.
A multiple measures placement policy may not be as simple or economical, compared to a policy that mandates placement based only on students’ test scores. Nevertheless, given the effects of placement procedures that consider multiple measures on initial student placement, the small increase in cost or complexity may be warranted. If students are initially placed in higher-level courses without risk to their success, they may be more likely to achieve their educational goals and improve transfer production.

Armstrong (1999) hypothesized that mandatory placement by test score denies access to higher-level mathematics instruction to some students who could complete higher-level courses successfully. Isbell (1988) and Jenkins (1991) confirmed that many students are successful in classes although test scores categorized them as unprepared for these classes. The student performance of Colorado community college students measured in this study supported the findings of Isbell and Jenkins.

The successful completion of college algebra for those CCCS students in the margin consistently proved to be a likely predictor of transfer to four-year institutions, suggesting that many more students can succeed in college-level gateway courses than are currently placed into them. If CCCS colleges were to consider college algebra the default placement for more students, these policy makers are left to determine why students should not start in college-level courses instead of why they may be blocked from them. Mandating student placement into lower-level courses when they could be successful at higher levels denies some students to engage fully in obtaining a college education (Marwick, 2010).

Placement policies that consider thoughtful multiple measures may provide the best balance between course objectives and students’ skills. Bracco (2014) suggested that
although test scores measure mathematics skills, high school mathematics preparation, and grades might have a stronger relationship to recent curricular changes and motivation. Some community college systems have been hesitant to use high school grade point average (GPA) for placement decisions, believing it may be too subjective—an assumption not borne out by the research (Bracco, 2014). In fact, studies indicate that even using high school GPA as the sole measure for placement decisions decreases “severe error” in college placement by 10% to 30% compared to the use of a single standardized test; and using a combination of GPA and standardized test results is a better predictor for college placement than any one measure alone (Scott-Clayton, 2012).

Finally, the self-determination theory would support allowing students to participate in placement decisions. Such a notion may serve to convey an important message about students’ responsibility for their own learning and the differences between high school and college. Ryan and Deci (2000) claimed that it is through acting on one’s inherent interests that one grows in knowledge and skills. Involving students in the placement decision could help them understand that they are responsible for their own learning. It also affirms a students’ ability to evaluate their capabilities and intrinsic motivation as they relate to their educational goals (O’Banion, 1997). It is likely, however, that if such a model were adopted, additional supports would need to be integrated in the college-level gateway courses.

Depending on the needs of the students, Complete College America (2014) identified three methods that have proven to be effective:

1. Single-semester co-requisites. This approach provides support to students enrolled in traditional single-semester, college-level gateway courses.
(2) One-course pathways. This approach stretches common single-semester gateway courses over two semesters and best supports those students in need of more academic help. This is an important strategy that CCCS may want to consider, ensuring students full credit that counts toward transfer.

(3) Parallel remediation. This approach is designed to address a student’s shortcomings in connection to a particular program of study. Again, this is an important strategy CCCS may want to consider, given the large number of Career and Technical Education programs offered.

However, it may be, however, that no single suggested placement methods would be optimal for all students.

**Summary**

In conclusion, a type II fuzzy regression discontinuity model is applied to a subset of Colorado community students who scored within the neighborhood (bandwidth) of the Accuplacer® Arithmetic Assessment cut score of 85 to see if the prescribed treatment (remediation) affects the likelihood that community college students will transfer to a four year institution. To sum up the overall results for math remediation, there is no statistically significant impact on the likelihood of transferring to a four-year institution when comparing outcomes for academically equivalent students with scores on the margin of the cut score. Math remediation, in and of itself, does not increase transfer production, the goal of Colorado Community College System

The results further indicate that the randomness associated with a single cut-score may not accurately measure college readiness and may rather lead to students being over-placed into remediation. These students may garner little or no educational benefit, but
will incur additional tuition and time costs. In spite of this recognition, the students on the margin are able to master college algebra. Accordingly, the completion of college algebra did prove to be a statistically significant predictor of transfer when included in this RDD equation, all of which supports the literature review and prior research.

A change to CCCS Board Policy 9-41 (Basic Skills Assessment) could possibly involve tradeoffs that could include precision and cost, test validity, face validity, individual college policy variation and uniform statewide system implementation. The heterogeneous nature of the CCCS students and the demographics of rural versus urban colleges offer constructs with unique and competing considerations. It may be difficult to identify placement policies that would be optimal for all students.

A number of assessment policy considerations are identified and offered to CCCS. These best practices, when coupled with the System’s current developmental education redesign program, may provide a comprehensive platform for getting students into a gateway course (i.e., college algebra) and hence, increasing the likelihood that CCCS students will transfer to a four-year institution.

- Consider establishing two cut scores: one that provides direct entry into standard college courses and another that signals very low level of readiness for college work, even with co requisite assistance.
- Expand the Accuplacer® Arithmetic Assessment from a single cut score to an acceptable range of scores.
- Use the Accuplacer® Arithmetic Assessment in conjunction with other indicators of college readiness, (i.e., writing samples, high school grade point average, high school class rank, TRiO eligibility).
• Include assessments that provide additional information about CCCS students’ non-cognitive and social cognitive skills.

• Consider college algebra to be the default placement for most students, or at the very least, allow students to enroll in the highest math class for which they have the prerequisite skills to be successful.

• Collaborate with K-12 to establish a combination of early assessment, early intervention, and multiple opportunities for high school students to demonstrate college readiness through course performance.

• Allow the CCCS students to actively participate in placement decisions.

*Core to College Evaluation* authors, Bracco, et al., (2014), offered encouraging preliminary results from two community colleges in Los Angeles. Their evaluations found that the use of multiple measures has increased students’ access to college-level courses without compromising students’ success in these courses. Colorado community college students could enjoy the same heighten success if CCCS policy makers agree that: (a) academic preparedness and college readiness may not be one and the same for many community college students, and (b) student success (i.e., transfer) depends on a variety of cognitive and non-cognitive skills and attributes—and any one measure on its own cannot provide a comprehensive assessment.
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Appendix A

CCCS Institutional Review Board Approval

MEMORANDUM

TO: Patricia A. Erjavec

FROM: Jerry Migler, Ph.D., IRB Chair

DATE: December 15, 2014

Subject: IRB Approval for the project titled “Does Remediation Affect the Likelihood that a Colorado Community Student Transfers to a Four-Year Institution?”

The Colorado Community College Institutional Review Board (IRB) has approved the protocol and related consent forms for the above named study on September 4, 2014. IRB approval is for a period of 12 months from the review day of September 4, 2014. If the protocol is to remain active longer, a written request for renewal together with a summary progress report must be submitted to the Board at least two months prior to September, 2015.

Federal regulations and Board policy require that you promptly report to the Board for review/approval:

No protocol changes may be initiated without IRB review and approval, unless necessary to eliminate an immediate hazard to subjects.

Serious adverse events and unanticipated problems involving risks must be reported to the IRB within 5 days.

No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date.

All recruitment materials and methods must be approved by the IRB prior to being used.

Please provide a final report to the Board when the project is completed and Board approval can be terminated. I wish you the best of luck on your research study.
Appendix B

UCCS Institutional Review Board Approval

University of Colorado
Colorado Springs

Institutional Review Board (IRB) for the Protection of Human Subjects

Date: 12/19/2014

IRB Review

IRB PROTOCOL NO.: 15-025
Protocol Title: Does Rememtixon Affect the Likelihood That a Colorado Community College Student Will Transfer to a Four-Year Institution?
Principal Investigator: Patricia Enrave
Faculty Advisor if Applicable: Al Ramirez
Application: Report of Change (I)
Type of Review: Exempt Category 4
Risk Level: No more than Minimal Risk
Renewal Review Level (If changed from original approval) if Applicable: Expedited
This Protocol involves a Vulnerable Population: N/A (No Vulnerable Population)
Expires: NA

*Note: if exempt: If there are no major changes in the research, protocol does not require review on a continuing basis by the IRB. In addition, the protocol may match more than one review category not listed.

Externally funded: ☒ No □ Yes
OSP #: 

Thank you for submitting your Request for IRB Review of a proposed change to your original IRB protocol. The protocol identified above has been reviewed according to the policies of this institution and the provisions of applicable federal regulations. The review category is noted above, along with the expiration date, if applicable.

You have requested a title change and the change in type of study: no longer collecting survey data thus, no longer requiring consent form.

Once human participant research has been approved, it is the Principal Investigator’s (PI) responsibility to report any changes in research activity related to the project:

• The PI must provide the IRB with all protocol and consent form amendments and revisions
  ◦ The IRB must approve these changes prior to implementation.

• All advertisements recruiting study subjects must also receive prior approval by the IRB.

• The PI must promptly inform the IRB of all unanticipated serious adverse (within 24 hours). All unanticipated adverse events must be reported to the IRB within 1 week (see 45CFR46.106b(a)). Failure to comply with these federally mandated responsibilities may result in suspension or termination of the project.

• Notify the IRB when the study is complete.

If you have any questions, please contact Research Compliance Specialist in the Office of Sponsored Programs at 719-255-3903 or irb@uccs.edu

Thank you for your concern about human subject protection issues, and good luck with your research.

Sincerely yours,

Michael L. Okin, PhD
IRB Reviewer