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Exploring The Relationship Between High School Diploma Requirements in Mathematics and College Remediation Rates

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EXPLORING THE RELATIONSHIP BETWEEN HIGH SCHOOL DIPLOMA
REQUIREMENTS IN MATHEMATICS AND COLLEGE REMEDIATION RATES

by
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“COLLEGE READINESS: AN EXAMINATION OF THE RELATIONSHIP BETWEEN HIGH SCHOOL GRADUATION REQUIREMENTS IN MATHEMATICS AND POSTSECONDARY REMEDIATION RATES,” a Doctoral research project prepared by DEREK J. BROWN in partial fulfillment of the requirements for the Doctor of Education degree in the Educational Foundations and Leadership Department.

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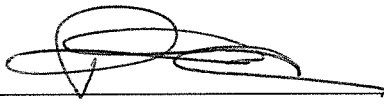
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Abstract

This study examined the relationship between the essential skill of math and college remediation rates using a dataset of 1,858 recent high school graduates attending public, 4-year Oregon universities. Using a logistic regression methodology, this study explored (a) the extent to which the essential skill of math improved college remediation rates, (b) the association between allowable essential skill of math sources of evidence and college remediation rates, and (c) the impact of the essential skill of math on students from various demographic backgrounds. Results from this study suggest the essential skill of math graduation requirement significantly predicts the likelihood of being enrolled in postsecondary math remedial coursework. In addition, high school GPA and SAT math scores predict the likelihood of math remediation, consistent with previous research in this area. Among students included in the sample, females were 29% less likely to be enrolled in math remediation. Other demographic variables did not significantly predict the likelihood of remediation. Evidence from this study shows a relationship between the essential skill of math graduation requirement and decreased remediation rates, although the effects may benefit some groups of students more than others. These results underscore the importance of rigorous academic content, sound assessment practice, and culturally responsive instruction aligned to standards for all students. This study may be used to inform future research in the area of minimum competency high school diploma requirements and postsecondary remediation practice.

Keywords: high school diploma, graduation, minimum competency requirements, mathematics, college remediation

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CHAPTER 1

INTRODUCTION

Several years ago, an Oregon school district superintendent told me a rather disheartening story about a recent high school graduate. The student, who I will refer to as Sara, had been very successful throughout her public school career. Sara was a popular student with many friends, involved in a variety of school groups and activities. Fellow students and faculty described Sara as a kind, warm-hearted person always willing to lend a helpful hand. In addition, Sara had performed very well academically, earning a 4.0 Grade Point Average (GPA) and selection as the class valedictorian. Sara had met one important milestone in her young life and had high expectations for the next steps in her journey.

Upon graduation, Sara moved to a nearby city to begin college. She was administered several entrance exams and was disappointed to be placed in remedial courses. Sara did not understand how she could have been so successful in high school, yet unprepared for credit-bearing, entry-level college coursework. Sara worked very hard to address the knowledge gaps, but became increasingly frustrated and disenfranchised with her lack of progress. In short, Sara was unable to keep pace with the rigor of college courses. Before the end of her first month as a college student, Sara decided to drop out and move back home. In addition to the emotional impact of such a decision, Sara was also confronted with the numerous financial consequences, such as financial aid repayment and housing.

Sara's story helps contextualize a broader issue many school districts in America have been struggling with for the better part of the past two decades: establishing meaningful high school graduation requirements that represent genuine college readiness. The transition from high school to college is so important that it has been highlighted in President Obama's

educational reform agenda (Obama, 2011). The notion of college readiness is complex in nature; it can be measured in a variety of ways, such as transcript analysis (Adelman, 2006; Long, Conger, & Iatarola, 2012; Long, Iatarola, & Conger, 2009; Hoyt & Sorensen, 2001; Chaney, Burgdorf, & Atash, 1997), and standardized test scores (Wyatt, Kobrin, Wiley, Camara, & Proestler, 2011; ACT, 2005a; Brown & Conley, 2007). Students who have not acquired the necessary knowledge and skill to successfully complete credit-bearing college courses are required to take remedial courses (Sparks & Malkus, 2013). Among students enrolled in their first or second year of college at public 4-year institutions in the 2011-12 school year, 28.7% had taken remedial courses (Skomsvold, 2014). Amos (2011) suggests the nation loses \$3.7 billion per year as a result of remediation services, including direct remedial courses in lost earnings. Interestingly, remedial courses are not the exclusive domain of lower-performing students. Rather, four out of five college students taking remedial courses surveyed in 2008 indicated they had earned a 3.0 GPA or better in high school (Strong American Schools, 2008).

College readiness is a multi-dimensional concept, and the ability to track it accurately has been a goal among school reform researchers and policymakers in recent years (Center for American Progress, 2009). There are a variety of factors that contribute to students' level of readiness as they complete high school and transition to postsecondary institutions. College readiness represents the level of knowledge and skill necessary for a student to enroll and succeed in credit-bearing courses (Conley, 2008). Succeeding in a credit-bearing course means completing 100 level college coursework, leading to the next appropriate courses in a program of study. According to Conley (2014), there are four critical facets to college readiness:

1. Key cognitive strategies
2. Key content knowledge

3. Key learning skills and techniques

4. Key transition knowledge and skills

Collectively, these elements of college readiness form a comprehensive framework, helping students, parents, and educators better understand the internal and external factors contributing to postsecondary success. In April 2014, the Oregon Education Investment Board (OEIB) adopted the following college and career readiness definition: “College- and career-ready Oregonians have acquired the knowledge, skills, and professional behaviors that provide a starting point to enter and succeed in workplace, career training, or college courses leading to certificates or degrees” (Oregon Education Investment Board, 2014). Key indicators of the OEIB definition include learning strategies, thinking skills, and academic knowledge, as well as transition skills and workplace behaviors. This definition is generally aligned to Conley’s framework, although narrower in scope. For example, the OEIB definition addresses the need for knowledge and skills to be successful in college courses, which aligns to Conley’s key cognitive strategies and key content knowledge. OEIB’s inclusion of professional behaviors is a reference to career readiness more than college readiness, although professional behaviors are akin to Conley’s key learning skills and techniques, separated merely by context. Finally, OEIB’s definition does not specifically address Conley’s key transition knowledge and skills.

In January 2007, the Oregon State Board of Education (SBE) adopted new high school graduation requirements, including increased credits, personalized learning requirements, and proficiency in the essential skills of reading, writing, and math. This culminating moment came after two years of partnership with The American Diploma Project (ADP), a coalition of 35 states working together to align high school standards, assessments, and graduation requirements. Throughout the decision-making process, feedback was collected from educators,

administrators, students, parents, local school board members, business leaders, and community members. Collectively, the fundamental goal of the new graduation requirements was to ensure each student leaves high school with the knowledge and skills necessary to be successful in college, career, and citizenship (Oregon Department of Education, 2008).

The essential skills were implemented in a staggered fashion, and applied based on when students entered high school, referred to as the “cohort year.” Students who entered high school in the 2008-2009 school year were required to demonstrate proficiency in the essential skill of reading to earn a regular diploma. Students who entered high school in the 2009-2010 school year were required to demonstrate proficiency in the essential skills of reading and writing. Finally, students who entered high school in the 2010-2011 school year were required to demonstrate proficiency in the essential skills of reading, writing, and math (Oregon Department of Education, 2015a). Students entering high school in 2010-2011 and beyond were required to demonstrate proficiency in the essential skills of reading, writing, and math to earn a regular diploma. Table 1 summarizes the essential skills graduation requirements by cohort.

Table 1

Essential Skills Graduation Requirements by Cohort

Cohort year	Essential Skill		
	Reading	Writing	Math
2008-2009	Required	N/A	N/A
2009-2010	Required	Required	N/A
2010-2011	Required	Required	Required

The essential skills are cross-disciplinary in nature and embedded in the academic content standards. Students may use a variety of sources of evidence to demonstrate proficiency in the essential skills, including (a) the Oregon Assessment of Knowledge and Skills (OAKS), (b) other approved standardized tests, and (c) work samples. Each source of evidence and corresponding

achievement standard, or “cut score,” is evaluated and approved by the State Board of Education. Work samples are performance assessments developed, administered, and scored by local school districts. The state provides general guidelines for development, administration, and scoring of work samples, but does not monitor local work sample policies or procedures closely. The essential skills represent the minimum level of knowledge and skills students should acquire by the end of high school. As such, the essential skills may be referred to as minimum competency requirements, and more accurately portray academic preparedness for credit-bearing postsecondary content, an important element of college readiness.

Statement of the Problem

The purpose of this study is to investigate the extent to which Oregon’s essential skill of math graduation requirement has improved college academic preparedness, encompassing two of Conley’s four dimensions of college readiness (key cognitive strategies and key content knowledge). Specifically, I will use a quantitative research design and existing data to ascertain the relationship between the essential skill of math graduation requirement and postsecondary remediation rates by comparing Oregon high school graduates from the classes of 2010, 2012, 2014, and 2015. In addition, I will examine the various sources of allowable evidence for the essential skill of math to ascertain the degree of consistency they provide in predicting 4-year postsecondary academic preparedness. An objective of this investigation is to better understand the relationship between high school minimum proficiency requirements in math and academic preparedness at 4-year postsecondary institutions.

Research Questions

This investigation will explore three primary research questions and three secondary questions.

Primary Research Questions

1. Did the 2014 essential skill of math graduation requirement improve remediation rates at Oregon public 4-year postsecondary institutions?
2. What is the association between the 2014 essential skill of math sources of evidence (OAKS and work samples) and remediation rates at Oregon public 4-year postsecondary institutions?
3. What is the impact of the 2014 essential skill of math on Oregon public 4-year postsecondary institution remediation rates for students from various demographic backgrounds, including male, female, historically underserved, students with disabilities, English language learners, and economically disadvantaged?

Secondary Research Questions

4. Among high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institution the following fall, is there a difference in remediation rates between the classes of 2010 and 2012, and the classes of 2014 and 2015?
5. Among 2014 and 2015 high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institution the following fall, is there a difference in remediation rates between those who used OAKS and work samples to meet the essential skill of math graduation requirement?
6. Which specific college readiness indicator has the greatest predictive power of the need for remedial coursework at Oregon public 4-year postsecondary institutions?

Definition of Terms

The following terms are relevant to this research study.

Academic preparedness:

The knowledge and skills necessary to be placed in entry-level, credit-bearing college courses without remediation (NAGB, 2009).

College readiness:

Academic and non-academic characteristics that allow students to access, enroll, and succeed in college. Conley (2008) refers to four dimensions capturing both academic and non-academic variables that interact to provide a comprehensive college readiness framework, including:

1. Key cognitive strategies: Intentional practices behaviors and patterns of thinking that lead to highly effective learning in a variety of situations.
2. Key content knowledge: The critical building block in core academic content areas that combined with the key cognitive strategies enable students to process, synthesize, and apply knowledge.
3. Academic behaviors: The self-management behaviors necessary for academic success, including organization, time management, reflection, resourcefulness, communication skills, note taking, and exam preparation.
4. Contextual skills and awareness: Accessing and utilizing the information necessary to understand and operate within the college system and culture.

Entry level credit-bearing courses:

Freshman level college courses identified by a course code of 100 or above.

Essential skill of math:

Minimum competency graduation requirement for students to earn a regular Oregon high school diploma. Includes the ability to apply mathematics in a variety of settings,

produce evidence to verify a solution, and communicate and defend methods. (Oregon Department of Education, 2015).

Exit exam:

Tests students must pass in order to earn a high school diploma (Center on Education Policy, 2012).

Remediation:

College courses designed to help students acquire the knowledge and skill necessary to progress to the next course in a sequence, but do not count toward degree completion (Scott-Clayton & Rodriguez, 2012). Remediation refers specifically to coursework assigned to students who do not possess the academic skills required for college, credit-bearing courses, as compared to *developmental education*, which refers to the broader support services available for students insufficiently prepared for college (Bailey, Jeong & Cho, 2010).

Limitations and Delimitations

There are a number of important limitations and delimitations associated with this study. The most notable limitation is the lack of consistency in remediation policies and practices across public 4-year postsecondary institutions. For example, there is some variance regarding the assessments and other sources of evidence colleges use to make decisions about freshman course placement. Many colleges emphasize placement test scores, while others evaluate a blend of test scores and high school transcripts. Furthermore, among commonly used placement tests, there is some variance regarding achievement standards and specific course placement. For example, the same score on a respective placement test could indicate an above 100 level, credit-

bearing course at one college, and below 100 level placement at another. As such, comparing remediation rates across postsecondary institutions is challenging.

School district implementation of the essential skill of math graduation requirement is another limitation of this study. The State Board of Education adopted the essential skills as graduation requirements in 2007. At that time, school districts, educators, students, and parents were notified the new requirements would be applied in a staggered fashion, beginning with the essential skill of reading for the class of 2012. This approach was designed to provide school districts and students the appropriate time to make instructional and programmatic adjustments in preparation for higher graduation expectations. Implementation strategies were determined locally, and varied from one district to the next. Furthermore, the use of allowable essential skill of math sources of evidence varied statewide. All school districts are required to administer state tests to students, per federal regulations; however, other sources of evidence, such as work samples, are administered based on a local determination of need and available resources. In this case, the intent of flexible policies is to benefit student outcomes. Conversely, the risks are inconsistency, validity, and fairness.

The implementation of new academic content standards represents another limitation to this study. In 2010, the Oregon SBE adopted the Common Core State Standards (CCSS) in English language arts and mathematics. The CCSS are more rigorous in nature, requiring students to (a) develop and apply higher level thinking skills; (b) synthesize, analyze, and explain solutions based on multiple sources of evidence, and; (c) engage with more complex texts and academic language. Similar to the essential skills graduation requirements, implementation of the CCSS was determined by school districts, based on resource availability and local prioritization. The CCSS represent significant shifts in teaching and learning, and were adopted

two years after the essential skills, but four years before the class of 2014 earned their diplomas. In other words, some of the students from the class of 2014 (the first required to demonstrate proficiency in the essential skill of math in order to graduate) may have received instruction based on both sets of academic content standards. The impact of the change in academic content standards on the essential skill of math graduation requirement is unclear, although likely mitigated given the variety of options students have to demonstrate proficiency.

In addition to variance in postsecondary remediation policies and inconsistent implementation of the essential skill of math graduation requirement and CCSS, there are several delimitations associated with this study. For example, I chose four school districts to derive the sample of graduates based on size and convenience of data. More specifically, I selected four large school districts with multiple high schools and demographic diversity. In addition, I chose to investigate graduates from the classes of 2010, 2012, 2014, and 2015. Comparing graduates across a four-year time span provides a clearer distinction between those students not required to meet the essential skill of math graduation requirement (classes of 2010 and 2012) and those required to do so (classes of 2014 and 2015). Lastly, I chose to include remediation data from public 4-year institutions in Oregon, rather than 2-year institutions, based on convenience of data.

Summary

College readiness has received increasing attention in recent years, as many high school graduates enter college settings unprepared to meet the academic challenges. To address this issue, the Oregon SBE adopted graduation requirements in 2007 designed to better prepare students for college level academic rigor, while mitigating the need for remedial coursework. The essential skill of math was the third minimum proficiency requirement applied to students in

the class of 2014, following the essential skills of reading in 2012, and writing in 2013. Students from this group were able to meet the essential skill of math requirement in a variety of ways, including state tests and local performance assessments called work samples. This study is designed to explore the association between the essential skill of math graduation requirement and remediation rates at public 4-year postsecondary institutions in Oregon. In addition, this study will examine the association between various sources of essential skill of math evidence and public 4-year postsecondary remediation rates. Finally, this study will investigate the impact of the essential skill of math graduation requirement on public 4-year postsecondary remediation rates of students from various demographic backgrounds.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

In the landmark report, “A Nation at Risk,” Gardner, Larsen, and Baker (1983) identified a variety of critical factors contributing to underachievement in American schools, including diluted coursework, ineffective content standards, and decreasing academic expectations. For the better part of the last 100 years, American high schools have been designed to (a) provide students with a spectrum of academic options matched with their respective interests, or (b) track students into specific career pathways (Conley, 2010). In reality, the model only worked for certain groups of students, while others were placed in particular programs often comprised of students with similar demographic backgrounds. As the global economy continues to shift, most careers require at least some postsecondary education, placing a greater premium on higher level thinking skills, problem solving, research, and communication for all students (Achieve, 2015).

A number of conceptual frameworks have been developed to create a more cohesive understanding of the knowledge and skills students need to compete in the global marketplace (National Education Association, 2015; Partnership for 21st Century Learning, n.d.; Skills21 at Education Connection, 2015). These knowledge and skills include critical thinking, global awareness, creativity, innovation, and digital literacy, for example. In addition, Dede (2006) points out the rise of information and communication technologies have changed the nature of personal interactions, making collaboration a cornerstone 21st century skill. In response to this need, many states have made deliberate efforts to better align content standards, graduation requirements, and assessments with the expectations of college and career (Achieve, 2012).

High school diploma requirements are designed to ensure students are equipped with the knowledge and skill they will need to be successful upon graduation. All states have standard diploma options for students, and many have alternative completion options for students with disabilities (Vernon, Baytops, McMahon, Padden, & Walther-Thomas, 2003). Growing skepticism regarding the efficacy of high school diplomas and what they truly represent requires the creation of a stronger link between graduation requirements and college coursework (American Diploma Project, 2004).

Graduation rates are often used to gauge the health and efficiency of high schools and skill of the future workforce. In the last ten years, U.S. graduation rates have ranged from 66% to 88%, largely due to the variance in calculations and diploma options (Heckman & LaFontaine, 2010). The graduation rate range for minority students during that time is even greater, at 50% to 85%. Green and Winters (2005) reported the national graduation rate remained flat between 1991 and 2002, moving from 72% to 71%. A record high 81% of students graduated in the Class of 2013, although traditionally underserved students continue to be overrepresented by high schools with lower graduation rates (Cardichon & Lovell, 2015). The inconsistent nature of graduation rate calculations and diploma options from one state to another limits the utility of the metric as a barometer for the overall health of the system. In other words, high school graduation does not necessarily provide evidence of college readiness (Somerville & Yi, 2002).

Many students leave high school unprepared for the academic rigor of college coursework (Green & Forster, 2003). Nearly one out of every three entering college freshman requires remedial education (Skomsvold, 2014; Cloud, 2002; NCES, 2003; Parsad & Lewis, 2003). ACT (2014) and The College Board (2015) have reported particularly low percentages of students as academically prepared for college, at 26% and 43%, respectively. Calcagno and

Long (2008) suggest college remediation improves early persistence, but offers limited benefits relative to long-term degree completion. Other research supports the claim that remedial education has a positive impact on course completion, grades, and degree attainment (Moss & Yeaton, 2013; Attewell, Lavin, Domina, & Levey, 2006; Bettinger & Long, 2004, 2009; Kreysa, 2007). Regardless of the effectiveness of remediation, many argue the real issue is the lack of alignment between high school graduation requirements and the knowledge and skill necessary to succeed in college (McCabe, 2001). College remediation affects all students, including high performers. One study found that 80% of remedial education students had earned a high school GPA of 3.0 or higher, and 59% indicated their high school courses were not challenging (Strong American Schools, 2008).

The purpose of this literature review is to create a better understanding of the relationship between high school graduation requirements and college remediation. Specifically, the following will be addressed: (a) defining and measuring college readiness, (b) defining and measuring remediation, and (c) the effects of remediation.

Defining and Measuring College Readiness

There are a number of ways to define and measure college readiness. Many indicators of college readiness focus on academic preparedness, such as course-taking, diploma completion, exit exams, Grade Point Average (GPA), and test scores, while others consider non-cognitive attributes, like organization and time management. There is little agreement among researchers on a common definition of college readiness.

Academic preparedness

College readiness is the key goal associated with many educational reform efforts, such as the adoption of the Common Core State Standards (CCSS). The National Assessment

Governing Board (NAGB) assembled a technical panel to review results from the 12th grade National Assessment of Educational Progress (NAEP) and determine whether or not those results could be used as a metric for college readiness relative to the CCSS (NAGB, 2009). The panel concluded the broader domain of college readiness subsumes academic preparedness, and defined academic preparedness as the knowledge and skills necessary to be placed in entry-level, credit-bearing college courses without remediation. This definition does not address the likelihood that a student will be *successful* in an entry-level, credit-bearing college course; rather, whether or not the student possesses the skills necessary to be placed in such courses without remediation (Loomis, 2011). Placement tests represent the limited data available to explore students' preparedness on the first day of college courses (Camara, 2013).

One key goal of the *No Child Left Behind* (NCLB) Act of 2001 was to ensure all students received high quality instruction based on college-readiness standards, leading to more students graduating and going to college. To that end, NCLB requires students to take tests in English language arts (ELA) and mathematics once per year in grades 3 through 8, and once in high school. The emphasis on high-stakes testing and interpretation of standardized test scores as a college readiness indicator may reveal more about high school students' academic preparation than true college readiness (Zhao, 2006, 2009). In many cases, this means students are indeed more academically prepared than in the past (Conley, 2007a, 2007b), yet may lack other more illusive college-ready traits, such as self-regulation (Young & Ley, 2003). In other words, to be successful in college, students must not only be academically prepared, they must also possess the self-awareness and self-control necessary to manage time, organize tasks, and utilize a range of learning strategies depending on the setting (Conley, 2010). Consequently, so long as college

readiness is primarily measured using standardized tests, it will be more appropriately defined as academic preparedness (Barnes, Slate, & Rojas-LeBouef, 2010).

High school course-taking and diploma requirements

To better prepare students for college, many states have increased minimum course requirements in ELA and mathematics. In fact, most states require students to earn a specific number of credits in various content areas to graduate, although the specific courses are not specified (American Diploma Project, 2004). The fundamental presumption is that the number of required courses and associated credits provides an accurate representation of college-readiness (Callan, Finney, Kirst, Usdan, & Venezia, 2006). For example, 42 states now require students to complete a minimum of three years of math in order to graduate (Buddin & Croft, 2014). States have a great deal of flexibility in determining and implementing course requirements. Interestingly, many states allow students with disabilities to earn diplomas through completion of modified courses and assessments (Samuels, 2015). In states characterized by local control governance models, school districts are given the authority to determine how students with disabilities meet graduation requirements, creating greater risk for potential equity and achievement gap issues (Thurlow, Ysseldyke, & Reid, 1997).

In a study of 3,765 entering freshmen at Utah Valley State College, Hoyt and Sorensen (2001) found that over 50% of students completing three years of high school English courses, and 35% of students completing four years, required remedial education. Similarly, Long, Conger, and Iatarola (2012) found that Florida high school students taking advanced coursework in any subject experienced a 7 to 11 percentage point increase in the likelihood of earning a high school diploma and enrolling at a 4-year college. Furthermore, the researchers revealed advanced coursework has similar effects for all demographic groups, with Hispanic, African-

American, and low-income students experiencing slightly greater graduation rate increases. In another study, Long, Iatarola, and Conger (2009) examined 73,261 records from Florida and found students made the most significant college readiness increases after completing Algebra 2 (25.6%, based on ACT test scores). African-American students completing Algebra 2 demonstrated significant gains compared to those who completed no higher than Algebra 1, while low-income students experienced modest gains at all course levels. These findings are reinforced by additional research connecting course-taking with increased college readiness, as measured by standardized assessments (Attewell & Domina, 2008; Gamoran & Hannigan, 2000; Nomi & Allensworth, 2009; ACT, 2005b). In sum, this body of evidence clearly demonstrates the positive impact of course-taking on academic preparedness.

Exit exams are tests students must pass in order to earn a high school diploma (Center on Education Policy, 2012). In the past ten years, the number of states implementing exit exams has increased significantly, with a total of 26 as of 2012 (Reardon, Arshan, Atteberry, & Kurlaender, 2010). The prevailing assumption is that tying diplomas to graduation will increase both student and school motivation (Dee & Jacob, 2006; Martorell, 2005; Ou, 2009; Warren, Jenkins, & Kulick, 2006). Exit exams, sometimes referred to as “high-stakes tests,” have been scrutinized for the incentives they create relative to school accountability policies, often leading schools to manipulate the population of students being tested (Heilig & Darling-Hammond, 2008).

The effects of failing exit exams for students have been explored comprehensively. In an examination of 46 studies pertaining to the influence of exit exams, Holme, Richards, Jimerson, and Cohen (2010) concluded (a) exit exams are not associated with increased student achievement, (b) exit exams are not associated with college attendance or completion, and (c) exit exams are associated with increased dropout rates for racial minorities and students

attending high-poverty schools. Using a regression discontinuity approach, Reardon et al. (2010) studied five cohorts of California students and found little evidence to suggest positive or negative effects of failing the state exit exam on motivation, behavior, and academic achievement. Similarly, Martorell (2005) found that students in Texas who barely failed exit exams were no more likely to drop out of high school than those who passed. Papay, Murnane, and Willett (2010) examined 66,347 Massachusetts students in grade 10, and found no effect on graduation rate for most students who failed the state exit exam in math. However, the researchers did suggest low-income students that failed the test experienced an 8% lower graduation rate.

Students with disabilities and English language learners (ELLs) may also be at risk of the negative effects of exit exams. Ou (2010) studied five high school cohorts in New Jersey (299,948 records) to better understand the association between barely passing or failing the state exit exam on high school persistence. The results suggested a 5-6% percentage point increase in the probability of dropping out of high school for all students, and a 14% increase in probability for ELLs. Solorzano (2008) points out there are a variety of issues associated with exit exams, such as technical quality and language classification alignment, that create potentially negative consequences and make them inappropriate for ELLs. Likewise, students with disabilities in states with exit exam policies are considerably more likely to receive an alternative exit certificate than their peers in non-exit exam states (Erickson, Kelinhammer-Tramill, Thurlow, 2007). The researchers claim the existence of an exit exam explains 28% of the variance in the frequency of alternative exit certificates awarded. Moreover, they point out the negative consequences of leaving high school with an alternative certificate can include limited access to college or the military, as well as ineligibility for financial aid. The collective body of research

on exit exams in the context of high school graduation requirements suggests there may be negative consequences for some students, although the use of exit exams as predictors or measurements of academic preparedness in college remains unclear.

High school GPA

Another commonly referenced metric for predicting college academic preparedness is high school GPA. Numerous studies have demonstrated a strong relationship between high school GPA and college success (DesJardins & Lindsay, 2008; Rothstein, 2002). Kobrin et al. (2008) analyzed a national sample of 105,530 first year college students and found high school GPA to be moderately predictive of college academic preparedness, as defined by first year college GPA ($r = .53$). The researchers noted high school GPA combined with SAT scores is an even stronger predictor of college academic preparedness ($r = .61$). Camara and Echternacht (2000) found similar results in a national sample of 46,379 students from 38 colleges. Correlation coefficients for high school GPA and first year college GPA ranged from .57 to .70. Using longitudinal data from 1980 through 2000, Zwick and Sklar (2005) found that high school GPA and SAT scores together explained 22% of the variance in first-year college GPA.

Belfield and Crosta (2012) examined community college data to compare the predictive ability of high school GPA with two commonly used college placement tests, Accuplacer and Compass. The researchers reported low correlations between placement test scores and first year college grades, $r = .10$ and $r = .17$ in English I for Accuplacer and Compass, respectively. Conversely, high school GPA showed moderate correlation with English I grades ($r = .34$). Interestingly, combining placement test data with high school GPA did not improve the overall predictive capability. Belfield and Crosta's findings support the claim that high school GPA is

more effective than placement tests in predicting first year community college success, explaining 21% of the variance in first year GPA.

Using a logistic regression model, Kowski (2013) studied 659 first-year community college students in New Jersey and found high school GPA to be the most significant variable in predicting math course placement. In fact, the findings indicated every point of increase in high school GPA represents 2.7 times greater likelihood of testing out of elementary algebra. Kowski tempers these results by explaining high school GPA represents a composite academic profile. In other words, high school students may or may not be academically prepared for college placement tests, depending on motivation, preparation, course-taking, and so on. As such, there are a number of issues associated with using high school GPA as a metric for college academic preparedness, including lack of standardization across high schools (course-taking, grading, etc.) and lack of diagnostic ability (Porter & Polikoff, 2012). Furthermore, students aware of the significance of high school GPA in the college admissions process may seek to raise their course grades by taking courses lower in rigor (Bishop & Mane, 2001). Despite these limitations, research findings support the notion that high school GPA is a strong predictor of academic preparedness in college.

Test scores

College readiness exams are generally recognized and publicly trusted as indicators of potential college success. Given the large numbers of students who participate in these assessments, they also provide a unique opportunity to compare results nationally. The ACT (2005a) definition of college readiness represents student achievement associated with a 75% chance of earning a course grade of C or better, or a 50% chance of earning a C or better, in entry level, credit-bearing college courses in English and math. ACT (2014) recently reported

that over 1.8 million graduates from the high school class of 2014 (57% of the U.S. graduating class) were administered ACT college readiness tests, with participation increasing 17.7% since 2010. Among them, 64% met the college readiness benchmark in English, 44% in reading, 43% in math, and 37% in science. Only 26%, or one in four students, met the benchmark in all four subjects. These percentages are remarkably stable since 2010, with the exception of reading, which has dropped from 52% to 44% during that time. Furthermore, the college readiness gap as described by ACT results remains prevalent. The percentage of African American, Hispanic, and American Indian students meeting the ACT college readiness benchmark in reading is 17%, 29%, and 25%, respectively. Again, based on demographic background, these percentages have been consistent over the past five years. Hoyt and Sorensen (2001) compared ACT results for students that had completed higher level English courses in high school across two school districts in Utah. They found the average ACT English score increased by five points in both districts for students taking higher level English courses.

The College Board definition of college readiness is based on the composite SAT score (including math, critical reading, and writing) associated with a 65% probability of earning a B- or higher first year college GPA (Wyatt, Kobrin, Wiley, Camara, & Proestler, 2011). A panel of content and assessment experts established this criterion to gauge college readiness through a standard-setting study (Kobrin, Patterson, Wiley, & Mattern, 2011). Approximately 1.6 million students from the class of 2014 took the SAT (The College Board, 2015). Among them, 42.6% met the SAT college- and career-readiness benchmark, including 15.8% and 23.4% for African American and Hispanic students, respectively. Similar to ACT, these results have changed very little over time.

While using SAT and ACT as proxies for measuring academic preparedness for college offers an array of benefits, such as being well-known, accessible, and useful as early warning systems, there are some risks (Zinth, 2012). For example, students who achieve a college-ready score by grade 11 may choose to take less rigorous courses during their senior year (Kirst, 2001). Furthermore, the predictive ability these tests offer, particularly for low income and minority students, has been challenged (Bettinger, Evans, & Pope, 2011; Geiser, 2009). Maruyama (2012) reviewed Minnesota and national data, concluding high school courses and GPA should be included with ACT scores to form a multivariate picture of academic preparedness.

Statewide summative assessments are also used to measure college academic preparedness. Each state is required by federal law (*No Child Left Behind*) to administer tests in English and math once per year to students in grades 3 through 8, and once in high school. These tests are designed to be in alignment with state academic content standards. Brown and Conley (2007) analyzed 60 English and math assessments from 20 states to determine the degree of alignment between what the tests measured (state academic content standards) and college-readiness criteria, which include (a) categorical concurrence, (b) depth of knowledge, (c) range of knowledge, and (d) balance of representation. The researchers found some alignment, more so in English than math, noting a general lack of alignment in areas requiring higher level thinking skills. Furthermore, Brown and Conley explain that state summative assessments cover only a portion of the knowledge and skill students need to be college-ready.

In addition to state tests, the National Assessment of Educational Progress (NAEP) provides a mechanism to monitor the health of college and career readiness at the national level. NAEP assessments are administered to a random selection of students in grades 4, 8, and 12 across the nation. The results of NAEP assessments have been remarkably stable in reading and

mathematics across each grade since the 1970s (U.S. Department of Education, National Center for Education Statistics, 2013). The scoring gap between white and African American high school students has gradually narrowed since 1971 from 53 to 27 scale points; the scoring gap between male and female students has also narrowed over time, although less significantly. Given the fact that many high school state tests are administered at grades 10 or 11, Kirst (2003) suggests the NAEP could mitigate the discrepancies between high school tests and college academic preparedness by providing a readiness baseline at grade 12. In other words, NAEP could provide useful indicators about the transition between secondary and postsecondary education systems.

Multiple indicator perspectives

In addition to the academic indicators described above, there are a number of college-readiness models framed by a multiple indicator perspective. In addition to content knowledge, some researchers suggest non-cognitive, or behavioral skills, are equally important to college success (Roderick, Nagaoka, & Coca, 2009; Mattern et al., 2014). Conley (2011) describes four critical facets to college readiness. At the center of his model, key cognitive strategies represent the intentional and practiced behaviors that form patterns of intellectual behavior. Key academic content knowledge represents the ability for a student to process, synthesize, and apply information in a given setting. Academic behaviors capture pertinent behaviors and individual attributes necessary to academic success, such as self-awareness, time management, study skills, and so on. Finally, contextual skills and awareness encompass an understanding of how college operates as a system and the underlying culture, including norms, values, and relationships. Conley's model strikes a balance between academic preparedness and non-academic awareness.

Wiley, Wyatt, and Camera (2010) developed a method utilizing three key indicators to predict college success, including SAT scores, high school grades, and academic rigor of high school courses. This multidimensional index defines college readiness based on a combination of SAT scores and other academic data. The researchers compiled data for 67,644 seniors from the graduating class of 2007 attending 110 postsecondary institutions. In their model, college readiness is defined as the probability of obtaining a B- or better on each of the three indicators, consistent with the college readiness definition supported by The College Board. Using a logistic regression analysis, the researchers determined 31.9% of students in the sample were college-ready based on all three indicators, including 38.2%, 9.8%, and 17.8% of white, African American, and Hispanic students, respectively. These results revealed a potentially more drastic picture of college readiness than previously cited research suggesting one out of three entering college freshman were not academically ready for college level courses. The advantage of multiple indicator models is the mitigation of risk in relying heavily on test scores alone (Pinkus, 2009), while providing a more complete picture of college-readiness.

Defining and Measuring Remediation

College remediation has received increasing public attention in recent years. According to Snyder and Dillow (2012), 38.6% of first-year undergraduate students in 2007 took at least one remedial course, including 4.5% that took three or more remedial courses. This represents an increase from 34.1% of first-year undergraduates in 2003. Similar to defining and measuring college readiness, there are a variety of methods for determining whether or not a student is required to complete remedial coursework. The most common method is through the use of placement tests. While placement tests are both convenient and accessible, there are some risks, such as misinterpretation of scores leading to placement error. Regardless of definition or

method of determination, the appropriateness of remediation as a core function of postsecondary institutions remains an open question.

Variance in policy and practice

There is a tremendous amount of variance in the policies and practices colleges use to determine which students will be placed in credit-bearing or remedial courses (Bettinger & Long, 2004). Many colleges operate autonomously, and are therefore able to establish placement and remediation policies independently (Attewell, Lavin, Domina, & Levey, 2006). As pointed out by Camara (2013), there are reasonable arguments to support flexibility in remediation determination, such as academic major. Furthermore, remediation policies are likely to vary as a result of differences in student bodies, departmental preference, and cost (Bettinger & Long, 2004). The broader consequence of inconsistencies in college remediation policies is a lack of alignment and transparency between public (K-12) and higher education systems.

Placement tests are the most commonly used method to determine whether or not a student is ready for college level coursework or better served in a remedial setting. In recent years, the effectiveness of placement tests has been called into question. For example, the timing of placement tests may contribute to the predictive value of the results, or lack thereof. Some high schools administer placement tests to students at the end of their senior year, while others administer similar tests in earlier high school grades to identify potential gaps in knowledge and skill (Kowski, 2013). As a result, some students have as much as one or two years of additional instruction to master content prior to completing a placement test (Frost, Coomes, & Lindeblad, 2009). Through student focus groups, interviews with admissions counselors, and surveys of matriculation officers from 73 California community colleges, Venezia, Bracco, and Nodine (2010) found that very few students understood the nature of placement tests prior to

administration, or had received any placement test orientation. Among the colleges that responded to the survey, fewer than half made practice placement tests available to students. In addition, many students indicated a lack of alignment between the placement test they were administered and the instruction they received in high school. Finally, many students did not understand the implications of their performance on placement tests relative to immediate access to credit-bearing courses.

Course placement determination can have a significant impact on tuition, access to content, and time to degree completion (Morgan & Michaelides, 2005). In many states, placement tests are the only source of evidence used to assign remedial courses (Collins, 2008; Hughes & Scott-Clayton, 2011). Presently, there are two regularly administered college placement tests: Accuplacer, developed by the College Board, and COMPASS, developed by ACT. Both organizations have produced documentation to support the technical quality of the tests, however no guidance has been provided to explain the extent to which students have been accurately assigned to courses based on test scores, or whether or not cut scores have been appropriately determined (Scott-Clayton, Crosta, & Belfield, 2014). In a study of New York community college placement test data, Belfield and Crosta (2012) observed that placement tests were not good predictors of course grades in remedial classes, with as many as three out of ten students being misplaced in English classes, and slightly lower rates of misplacement in math classes. Assigning prepared students to remedial coursework produces minimal educational benefit, while increasing cost and delaying degree attainment (Scott-Clayton, Crosta, & Belfield, 2014). In addition, assigning underprepared students to college-level courses not only negatively impacts their academic progress, but may also lower the achievement of their peers (Carrell, Fullerton, & West, 2009).

Given the lack of predictive validity and high stakes nature of some placement tests, there is an increased need to investigate multiple sources of evidence in the determination of remedial treatment. Scott-Clayton (2012) analyzed 42,000 first-year community college students in New York to better understand the accuracy of placement tests, as well as extent to which additional sources of evidence reduced placement error. The researcher discovered placement tests were more predictive of passing an entry-level college course in math than in English, and that using placement tests alone is less predictive of success in English and math than using high school GPA. In addition, combining placement test scores with high school GPA may reduce placement error by 15%. Belfield, Crosta, and Belfield (2012) also found stronger predictive relationships when combining placement test scores with high school GPA, although the researchers suggest high school GPA alone may be sufficient in explaining college outcomes. A number of states, including North Carolina, Texas, and Connecticut are in the process of implementing more holistic evaluations to determine remedial course placement, but face challenges such as integrating data systems, confirming the “shelf life” of high school grades, and withstanding the time it takes to implement systems level policies (Burdman, 2012).

Remediation as a core function

There are varying opinions regarding the appropriateness of remediation as a core function of 4-year colleges and universities. Some argue that remedial coursework is diversionary in nature with little long term effect (Scott-Clayton & Rodriguez, 2012; Schmidt, 2008). In other words, remediation does not positively or negatively affect college persistence or degree attainment. Others suggest the existence of remedial courses signals a false promise to academically unprepared students unlikely to graduate (Deil-Amen & Rosenbaum, 2002). Bettinger and Long (2004) recommend students in need of remedial courses be directed to

community colleges for appropriate treatment. The extent to which remediation is misdiagnosed or perceived as an obstacle to degree completion contributes to the scrutiny these services will receive as core functions of 4-year colleges.

Conversely, remediation is also viewed as a necessity in college and university settings for several reasons. First, colleges have a responsibility to educate a wide range citizens, regardless of the degree to which those services are corrective in nature (Rose, 2009). In fact, remediation is designed specifically to provide “a bridge of educational opportunity for those who would otherwise be shunted off the path of economic stability into a wilderness of dead-end jobs, poor health care, limited housing opportunities, and a myriad of other social ills” (Bahr, 2010, p. 232). Second, remediation is a sound investment for society relative to increased economic outcomes, reduced crime rates, and increased quality of life (Phipps, 1998). In other words, remedial education as a college function is aligned to the broader mission of contributing to the betterment of society. Third, and most important, traditionally underserved students are overrepresented in remedial college courses (Attewell, Lavin, Domina, & Levey, 2006). As a result, limiting remedial services likely reduces access to college-level content for some students. Simply put, the primary result of removing or limiting remediation as a core service will result in greater marginalization of some groups from higher education (Rose, 2009).

Effects of Remediation

The effects of remediation are widely debated, and often discussed relative to increasing student achievement and persistence toward degree completion. While some researchers have confirmed the effectiveness of remediation (Moss & Yeaton, 2013; Bettinger & Long, 2009; Calcagno & Long, 2008), others have produced evidence to demonstrate remediation offers little to no positive impact (Scott-Clayton & Rodriguez, 2012; Martorell & McFarlin Jr.; Boatman &

Long, 2010; Bahr, 2010). Regardless of the effectiveness of remedial treatment, the merits and appropriateness of these services will remain in question as the need to address academically underprepared students continues to increase (Davis & Palmer, 2010).

Growing need for remedial services

College remediation in the United States can be traced back to the early 1800s. Reports and speeches from Yale and Harvard demonstrate remediation was an active conversation, with arguments both for and against the appropriateness of providing treatment (Spann, 2000). Current research suggests a steady increase in remedial coursework nationally (Tierney & Garcia, 2011). As discussed previously, remedial course enrollment rates are a commonly used metric to judge the degree to which the public education system is academically preparing students for college. During the 1999-2000 school year, 25% of first-year undergraduate students at 4-year universities enrolled in at least one remedial course. The percentage dropped to 18% in 2003-2004, then rose to 21% in 2007-2008 (Sparks & Malkus, 2013). Remediation is more likely for African American and Hispanic students, with 30% and 29% enrolling in at least one remedial course in 2007-2008, respectively. In 2011-2012, 29% of first- and second-year undergraduates at 4-year universities enrolled in at least one remedial course, including 38% of African American and 38% of Hispanic students (Skomsvold, 2014). Furthermore, 35% of female and 30% of male first- and second-year undergraduates enrolled in at least one remedial course in 2011-2012. These statistics show some improvement between 1999-2000 and 2003-2004, with increasing rates of remediation from that point through 2011-2012. This evidence suggests there is a continuous and growing need for remedial services at the college level.

There is little research available to explain the overall costs of remedial education (Kirst, 2007). According to Amos (2011), \$1.4 billion dollars are spent annually by colleges to provide

remedial courses; students enrolled in remedial courses that eventually drop out of college represent an additional estimated \$2.3 billion dollars in lost earnings, resulting in a \$3.7 billion dollar annual impact on the economy. In Oregon, approximately \$30 million dollars may be saved by reducing the need for remediation in community colleges (Amos, 2011). Consistent with Amos, other research suggests annual remediation costs reach \$1 billion dollars nationally (ACT, 2005b; Brothen & Wambach, 2004). At the institution level, Merrow (2007) suggests remedial programs are less expensive to operate than other academic programs, and that remedial courses generate sufficient revenue to cover costs. In other words, remediation pays for itself while benefitting other educational programs (Martinez & Bain, 2013; Saxon & Boylan, 2001). For students, while the cost per credit for remedial courses may generally be lower than credit-bearing courses (Phipps, 1998), those enrolled in these courses experience hidden costs relative to the extended time necessary to complete their degrees (Conley, 2007c; Venezia, Kirst & Antonio, 2004).

Positive effects of remediation

Persistence, course grades, and degree completion are commonly cited as positive effects of college-level remediation. Using a quasi-experimental design to study over 28,000 Ohio undergraduates, Bettinger and Long (2009) revealed students remediated in English and math were more likely to persist over five years of college and experienced increased likelihood of degree completion. For example, when controlling for ACT math scores (mean 17.68), students receiving remedial math treatment were 14% less likely to drop out of college. Similarly, when controlling for English ACT scores (mean 15.66), students receiving remedial English treatment were 11.7% less likely to drop out of college. Furthermore, the researchers reported students with higher ACT scores receiving English and math remediation were 9.3% and 9%,

respectively, more likely to complete their degrees, although the effects of English remediation tended to decline as ACT scores increased. In other words, higher ability students benefited from math remediation, while the effects of English remediation varied depending on ability level. Bettinger and Long's research suggests remediated students experience improved student outcomes (persistence and degree completion), as compared to similar students receiving no remedial treatments.

Calcagno and Long (2008) investigated a data set of 100,000 community college students from Florida and revealed some evidence to support the claim that remediation improves persistence. After controlling for the placement test cutoff score, the researchers found students on the margin of requiring math remediation experienced slight increases (2 to 3.8 percentage points) in likelihood to persist from the first to second year of college. Moreover, students receiving remedial treatment earned 7.2 more math and 2.8 more reading credits toward degree completion than non-remedial students.

Course grades are another important indicator of the effects of remediation. In a study of 3,589 first-year community college students, Moss and Yeaton (2013) found students completing remedial courses in English experienced increased achievement by one fifth to one half a grade point (course grade). In addition, students participating in English remediation were 1.56 times as likely to pass college-level English (odds ratio [OR] = 1.56). Males and White students appeared to benefit significantly from remedial English courses (OR = 1.77, 1.5, respectively). Using data from the National Longitudinal Data Study (NELS:88), Attewell, Lavin, Domina, and Levey (2006) examined 6,879 students and found remedial treatment had no negative effects on likelihood of degree completion at 2-year institutions (community colleges); however, similar students were 7% less likely to graduate at 4-year colleges. These studies suggest remediation

may improve persistence and achievement, but do not confirm remedial treatment improves the likelihood of degree completion.

Little or no effects of remediation

There is a variety of research to support the claim that remediation has no positive effect on college outcomes. Martorell and McFarlin (2011) studied 250,000 students in 2- and 4-year Texas colleges. Their analysis suggests remediation negatively effects college persistence. Moreover, the researchers point out remediation may create a small negative effect relative to credits attempted and likelihood of completing the first year of college. Similarly, Scott-Clayton and Rodriguez (2012) examined first-year college students from six large urban community colleges, finding no evidence to suggest remediation had improved outcomes. Rather, the researchers suggest the effects of remediation are diversionary in nature; for example, they found students assigned to remediation more likely to delay enrollment initially, with no impact on students enrolling within three years of remedial placement.

In a study of first-year undergraduates in Tennessee, Boatman and Long (2010) explored the effects of remediation using regression discontinuity based on COMPASS scores just above and below the cutoff for remedial course placement. The researchers explained that students receiving remedial treatment accumulated fewer college-level credits over time. For example, students receiving upper-level math remediation (those scoring at or just below the cutoff for remediation) took nearly 6.5 fewer college-level credits by the end of their third year than non-remedial students, as compared to students receiving lower-level math remediation who took three fewer college-level credits over the same time span. These results suggest effects that are more negative for those students at the margins of remedial identification.

In a longitudinal study of English language learners (ELLs) from Texas, Flores and Drake (2014) analyzed factors that predict the need for remedial treatment for any student ever identified as ELL. The study followed a group of students who entered first grade in 1995, graduated from high school in the spring of 2007, and entered college the fall of 2007. The findings suggest ELL students are more likely to enroll in remedial college courses, although Hispanic ELL students receiving one to three years of language instruction were less likely to need remedial services than non-ELL Hispanic students. In a study of 63,147 first-year undergraduates in California community colleges, Bahr (2010) investigated the relationship between race and math remediation, as well as degree of math deficiency, English competency, performance in first math course, student's primary academic goal, and enrollment patterns. The study revealed significant differences in likelihood of successful remediation relative to race. For example, White students were 3.1 times and 1.6 times more likely to successfully remediate than Black and Hispanic students, respectively. Overall, remediation success rates were very low, as only one in four students completed a credit-bearing course within six years of enrollment. This body of research underscores the importance of high quality language instruction, given the inconsistent nature of remedial success rates for various groups of students.

Calcagno and Long (2008) studied 100,000 first-year community college students in Florida and found little evidence to suggest remediation helps or harms student outcomes. Math remediation, for example, had no noticeable effect on college-level credits earned, certificate or associate degree completion, or transfer to a public 4-year university. The effects of reading remediation were similar. Bettinger and Long (2004) found remedial math placement increased the likelihood of drop out or transfer to a community college, as compared to non-remediated students. As a result of their study of 8,600 first-year undergraduate students enrolled at public

4-year universities in Ohio, the researchers suggest placement into remedial courses encourages students to reevaluate their level of academic preparation before enrollment. Conversely, students completing remedial coursework were less likely to drop out than those merely placed in remediation, suggesting a potential positive effect on persistence.

Conclusions from the Literature

College readiness is defined in a variety of ways. Several conceptual frameworks have been developed to describe the knowledge and skills students must possess to be successful in college, both academic and non-academic in nature. As states have implemented graduation requirements designed to improve students' college readiness, there has been sustained criticism that the public education system is not adequately preparing students for college, as defined by stagnant graduation rates and performance on nationally-normed assessments. Most indicators of college readiness focus on the academic element, such as diploma completion, high school GPA, and test scores. These indicators more accurately reflect students' academic preparedness. Other college readiness frameworks include non-academic indicators, such as time management and organization. Research has produced clear evidence to support the positive impact of course-taking on academic preparedness. In addition, high school GPA and nationally-normed college readiness assessments, like the SAT or ACT, are strong predictors of academic preparedness. Conversely, high school exit exams may negatively affect college outcomes, particularly for ELLs and students with disabilities. Finally, researchers have explored the feasibility of using multiple sources of evidence to predict college success, leading to greater balance between academic preparedness and non-academic awareness.

Similar to college readiness, college remediation is defined in a variety of ways. The policies and practices that guide remedial course placement decision-making vary significantly

from one college to the next. As a result, similar students might receive very different remedial and non-remedial treatment depending on which college they enroll. Placement tests are the most commonly used device to collect information about individual student readiness for credit-bearing coursework. Research has produced evidence to suggest placement tests lack accuracy. Moreover, given the inconsistent nature of remediation policy, the validity of both the instruments and decision-making process has been questioned. There are mixed beliefs regarding the appropriateness of remediation as a core function of college services. Some argue remediation is diversionary, yielding little long-term effect; others believe content remediation sends a false promise to unprepared students. Remediation is also viewed as not only an appropriate core function, but also a moral responsibility. Moreover, remediation is a sound investment in society, providing access to educational opportunity for those who need it most.

The effects of remediation are mixed. There are bodies of research confirming both the effectiveness and ineffectiveness of remediation. College remediation has a long history in the United States. In the past 20 years, remediation rates have remained relatively stable, with as many as one in three undergraduate students enrolling in at least one remedial course. Remediation is an expensive enterprise at an estimated \$1.4 billion annually. Researchers have argued remediation improves persistence, achievement, and degree attainment, while others have shown remediation negatively affects persistence and decreases the likelihood of degree attainment, particularly for certain groups of students. In sum, the effects of remediation likely vary depending on the presence of other student supports.

Contributions to the Literature

This research contributes to the literature on the relationship between high school graduation requirements and improved student outcomes (Buddin & Croft, 2014; Amos, 2011; Vernon, Baytops, McMahon, Padden, & Walther-Thomas, 2003; Bishop & Mane, 2001). In addition, this research contributes to the literature by exploring various sources of evidence used to predict college academic preparedness (DesJardins & Lindsay, 2008; Long, Iatarola, & Conger, 2009; Rothstein, 2002; Attewell & Domina, 2008; Gamoran & Hannigan, 2000; Nomi & Allensworth, 2009; Zwick and Sklar, 2005; Belfield & Crosta, 2012; Kowski, 2013; Wiley, Wyatt, & Camera, 2010). This study investigates the relationship between high school minimum competency requirements for graduation and academic preparedness for college-level coursework, and is similar in nature to the work of Buddin and Croft (2014), and Hoyt and Sorensen (2001). The fundamental difference between these studies is the definition of treatment: this study examines the essential skill of math as a certification of academic preparedness for college, while the previously mentioned research examines the effect of course-taking on academic preparedness.

CHAPTER 3

METHODS

Introduction

This study investigated the relationship between minimum high school competency requirements in math and college readiness. Specifically, using data obtained from the Oregon Higher Education Coordinating Commission (HECC) and the Oregon Department of Education (ODE), this research sought to explain the association between the essential skill of math graduation requirement and remediation rates in 4-year public universities while controlling for the following variables: essential skill of math source of evidence (state test or work sample), graduating class, high school GPA, standardized test scores (SAT and state test), race, gender, socioeconomic status (SES), special education status, and English language learner (ELL) status. Findings from this study will inform state policymakers regarding the effectiveness of the essential skill of math graduation requirement, as well as the efficacy of the various sources of allowable evidence. In addition, this research may inform local school districts in program improvement and policy implementation efforts. To that end, this study is framed by three primary research questions:

1. Did the 2014 essential skill of math graduation requirement improve remediation rates at Oregon public 4-year postsecondary institutions?
2. What is the association between the 2014 essential skill of math sources of evidence (OAKS and work samples) and remediation rates at Oregon public 4-year postsecondary institutions?
3. What is the impact of the 2014 essential skill of math on Oregon public 4-year postsecondary institution remediation rates for students from various demographic

backgrounds, including male, female, historically underserved, students with disabilities, English language learners, and economically disadvantaged?

Research Design and Nature of the Data Set

The data sets used in this study include:

1. HECC student level data
 - a. First name
 - b. Last name
 - c. Date of birth
 - d. Gender
 - e. Ethnicity
 - f. High school
 - g. High school GPA
 - h. Enrolled college courses
 - i. Course titles
 - j. Course numbers
 - k. Course credits
 - l. SAT math score
2. ODE student level data
 - a. First name
 - b. Last name
 - c. Date of birth
 - d. Gender
 - e. Economically disadvantaged (if applicable)

- f. English language learner (if applicable)
- g. Special education (if applicable)
- h. Essential skill of math source of evidence
- i. Highest high school OAKS math test score

The HECC collects remedial coursework information from 4-year public postsecondary institutions on an annual basis. The data set includes course prefix, course number, course title, and associated credit hours. These data elements are provided at the student level and are representative of all enrolled students, including those from out of state. Courses numbers below the 100-level are considered remedial, in that students do not earn credits as a result of these courses. In addition to remedial coursework, the HECC also collects student level high school GPA, SAT math score, and ethnicity information. Data from this collection from 2010, 2012, 2014, and 2015 was included in this study

The ODE collects student level results from state tests required by the Elementary and Secondary Education Act (ESEA). These tests, known as the Oregon Assessment of Knowledge and Skills (OAKS), are administered once per year in grades 3 through 8, and once in high school at grade 11 in English language arts (ELA) and mathematics. ELA tests are administered separately in reading and writing. In addition, the ODE collects essential skill of math source of evidence data from school districts when student graduate with a regular diploma. Students may use a variety of sources of evidence to demonstrate proficiency in the essential skills, including OAKS tests, other approved standardized tests, and work samples. Given the fact that other approved standardized tests are utilized by less than 1% of students demonstrating proficiency in the essential skill of math, this study compared the association between OAKS tests and work

samples with postsecondary remediation. Data from these collections for the classes of 2010, 2012, 2014, and 2015 was included in this study.

Convenience sampling was utilized for this study. The school districts selected have consistently submitted higher quality (complete) data described above, which mitigates potential issues associated with small sample sizes. Participants included in this study are students who earned a regular Oregon high school diploma from four large school districts in the classes of 2010, 2012, 2014, and 2015 that enrolled in courses at a 4-year public university in Oregon the following fall. These graduating classes have been selected for this study because they represented two classes *not required* to demonstrate proficiency in the essential skill of math (2010 and 2012), and two classes *required* to satisfy the essential skill of math graduation requirement (2014 and 2015). Investigating two classes before and two classes after the implementation of the essential skill of math increases the sample size and mitigates potential validity threats by capturing a broader snapshot of delayed implementation effects. According to Hosmer, Lemeshow, and Sturdivant (2013), logistic regression requires 10 cases per parameter (independent variable). In this study, 10 independent variables will be included, requiring a minimum sample size of 100.

In order to create a consolidated file that includes the required data elements for each student, I combined fields from the files provided by the HECC and the ODE using the Statistical Package for the Social Sciences (SPSS) 22.0. To do so, I requested student level identifying information, including first name, last name, birthdate, and gender. These data elements allowed me to link individual students across the two data sets, in order to produce a single file with the required fields, including name, race/ethnicity, birthdate, high school GPA, OAKS math scores, SAT math scores, remedial course title and number, and title. In addition,

each student record included indicators for economically disadvantaged, English language learner, and special education, as applicable. These indicators are not mutually exclusive, meaning students may represent a combination of indicators.

Inclusion criteria for this study describe the conditions necessary for a student record to be included in the analysis. First, students must be graduates from one of the comprehensive high schools from the selected school districts in the classes of 2010, 2012, 2014, or 2015. Second, students must have enrolled at one of the seven public, 4-year colleges or universities in Oregon the following fall after high school graduation. For example, a student graduating in the class of 2010 was only included if he or she enrolled in college during the fall of 2010. This logic was also applied to early high school graduates, meaning students who graduated in the fall or winter of the school year, but were counted in the spring class of 2010, 2012, 2014, or 2015.

Exclusion criteria for this study describe the conditions under which a student record was removed from the analysis. Student records that did not include high school GPA, OAKS math score, essential skill of math source of evidence, or enrolled college course numbers were excluded from the final sample. In addition, student records that did not include enrollment in at least one postsecondary math course were excluded from the analysis. In other words, if student records reflected elective course enrollment exclusively, they were removed from the analysis. This approach mitigated the risk associated with identifying students enrolled in electives only as non-remedial. The validity concern is lack of understanding whether or not the student required remedial treatment, given their personal choice in course enrollment.

Dependent and Independent Variables

Dependent and independent variables are conceptualized and operationalized as follows:

Dependent Variable:

- Remediation – conceptualized as treatment delivered as a result of lack of academic preparedness; operationalized as remedial course enrollment in the first term (fall) of college, treated as a dummy variable: yes (1), no (0). Remedial designation of yes (1) was applied if the student was enrolled in one or more remedial courses.

Independent Variables:

- High school graduating class – conceptualized as the year in which a student graduates from a high school with a diploma; operationalized as a categorical variable based on the year students graduated from high school: 2010 and 2012 (0), 2014 and 2015 (1). Treatment designation of yes (1) denotes the student was required to satisfy the essential skill of math requirement to earn a regular diploma.
- High school GPA – conceptualized as an indicator of cumulative performance in high school courses, and as an indicator of academic preparedness for college; operationalized as a continuous variable based on composite high school GPA: (0.00 – 4.0).
- OAKS math test score – conceptualized as an indicator of knowledge and skill relative to the academic content standards from which instruction is derived, and as an indicator of academic preparedness for college; operationalized as a continuous variable based on state math test score: (0 – 300). OAKS math tests are available to high school students three times per year at each high school grade, representing 12 total opportunities. I used the best score for each student.

- Scholastic Aptitude Test (SAT) math score – conceptualized as a predictor of future college success, and as an indicator of academic preparedness for college; operationalized as a continuous variable based on SAT math score: (200 – 800).
- Essential skill of math source of evidence – conceptualized as equivalent demonstrations of proficiency of the ability to apply mathematics in a variety of settings; operationalized as the source of evidence indicated to demonstrate proficiency in the essential skill of math, treated as a dummy variable: Work Samples (1), OAKS math test (0).
- Race/ethnicity – conceptualized as a categorical variable based on student self-identification of race/ethnicity. Operationalized as historically underserved groups including African American, Hispanic, American Indian/Alaska Native, Pacific Islander, Unknown, and Non-resident Alien, remaining groups include White, Asian, and Two or More; treated as a dummy variable: historically underserved (1) remaining cases (0).
- Gender – conceptualized and operationalized as a categorical variable based on male or female gender identification: female (1), male (0).
- Socioeconomic status – conceptualized as a student who participated in or is eligible for the free and reduced school lunch program; operationalized as a categorical variable based on identification as economically disadvantaged: yes (1), no (0).
- English language learner – conceptualized as a student who participated in or is eligible for the limited English proficiency program; operationalized as a

categorical variable based on identification as an English language learner: yes (1), no (0).

- Special education – conceptualized as a student who received special education services at any time during the school year as part of an Individualized Educational Program (IEP); operationalized as a categorical variable based on identification as a student receiving special education services: yes (1), no (0).

Data Analysis

Data analysis was conducted using a logistic regression analysis. As compared to linear (simple) and multiple regression, logistic regression is used when the dependent variable is binary rather than continuous. In this case, the dependent variable is binary (college remediation: yes or no). Using the independent variables listed above, logistic regression was the appropriate method to examine the extent to which these variables are associated with, or predict, remediation (Hosmer, Lemeshow, & Sturdivant, 2013). In this case, logistic regression revealed which indicators were most influential. Furthermore, logistic regression confirmed the extent to which the inclusion of each indicator increased or decreased the likelihood of the outcome (remediation). Logistic regression also explained the relationship between the two primary sources of evidence used to satisfy the essential skill of math (OAKS or work samples) and remediation rates, while controlling for the independent variables listed above.

Logistic regression is founded on the concept of a logit, or odds ratio. The logit represents the likelihood of a respective outcome, given the independent variables (Mertler & Vannatta, 2005). Logistic regression is different than linear (simple) regression, in that the latter describes the degree to which two continuous variables are related in a linear fashion, while the former describes the percentage chance of a binary outcome (e.g., yes or no, pass or fail)

(Linneman, 2014). In other words, logistic regression predicts the probability of specific outcomes. Logistic regression is particularly fitting when testing the relationships between a binary dependent variable and multiple categorical or continuous independent variables (Peng, Lee, & Ingersoll, 2002). In this study, the dependent variable (remediation) is binary, and the independent variables are both categorical and continuous. Logistic regression utilizing multiple indicators (X_1 = SAT math score, X_2 = HS GPA, X_3 = gender) can be constructed to predict the likelihood of an outcome (Y = remediation) in the following manner:

$$\text{logit}(Y) = \ln \left[\frac{\pi}{1 - \pi} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

In the equation, π represents the probability of the event (remediation), α is the Y intercept, β s are the regression coefficients, and X s are the independent variables (Peng, Lee, & Ingersoll, 2002). In other words, the logistic regression model explains the extent to which independent variables increase and decrease the likelihood of remedial treatment. For example, I investigated the likelihood of remediation as high school GPA and OAKS math scores increase or decrease. A similar analysis was applied to compare groups of students, as well as students using work samples compared to OAKS as the source of evidence for the essential skill of math.

In this study, the null hypothesis was defined as no relationship between the essential skill of math graduation requirement and college remediation treatment. As such, all β s would be zero. A rejection of the null hypothesis may be inferred if the β s are not statistically different from zero, meaning the regression did predict the outcome. In other words, there is a relationship between the treatment and the outcome, which can be represented using an odds ratio for all independent variables (Peng, Lee, & Ingersoll, 2002).

An odds ratio is an appropriate method for explaining the likelihood of an event occurring, and is derived by dividing the probability of an event occurring by the probability of

the event not occurring (Field, 2013). Odds ratios greater than 1 indicate that as an independent variable increases, so do the odds of the outcome occurring. Conversely, odds ratios less than 1 indicate that as an independent variable increases, the odds of the outcome occurring decrease. In this study, odds ratios are reported to describe the likelihood of remediation as independent variables increase or decrease. Odds ratios are derived as follows:

$$Odds = \frac{p}{1 - p}$$

For example, I can calculate the odds that male and female students will receive remediation. If the probability (p) of male students receiving remediation is 60%, or .6, I divide that number by the probability of no remediation, 40%, or .4, which equals 1.5. In other words, male students are one and a half times as likely to be enrolled in remedial coursework. The same analysis was applied to other predictors, including continuous independent variables (high school GPA, SAT math score).

I used the SPSS 22.0 on a Microsoft Surface, Windows 8.1 environment to complete this logistic regression analysis. Descriptive statistics, including mean, standard deviation, minimum, maximum, and sample size are presented in tables to contextualize the analysis. Descriptive statistics are important in data interpretation to explain (a) the range of the distribution, (b) the center of the distribution, and (c) how far individual data points are from the center (Linneman, 2014).

Frequencies are provided for categorical variables, such as gender and essential skill source of evidence. Sample size (n) is provided for each of the four graduating classes including in the analysis, disaggregated by historically underserved and other special identifier (ELL, special education, economically disadvantaged). Continuous variables are described using the mean (average) to illustrate central tendency. In addition, standard deviation is provided to

measure the size of deviations or variance from the center. In a normal distribution, approximately 68% of the observations fall within one standard deviation of the mean (above or below), 95% of the observations fall within two standard deviations from the mean, and 99.7% of the observations fall within three standard deviations from the mean. In this study, mean, standard deviation, minimum, maximum, and sample size are provided for high school GPA, OAKS math score, and SAT math score.

The results of the analysis include (a) an evaluation of the logistic regression model, (b) statistical tests of individual predictors, (c) goodness-of-fit statistics, and (d) an assessment of the predicted probabilities (Peng, Lee, & Ingersoll, 2002). Likelihood ratio and Wald statistics were used to test the null hypothesis (H_0) in the model (Harrell, Jr., 2001). To evaluate the significance of predictors (regression coefficients), the linearity between the logit and each independent variable were tested using the *Wald statistic*, a type of chi-square (χ^2) analysis (Boslaugh, 2013). The Wald statistic is similar to the *t*-test in linear regression, which describes the difference-in-means of two samples. In other words, the Wald statistic explains the degree to which a particular variable contributes significantly to a predicted outcome (Field, 2013).

Goodness-of-fit statistics measure the fit of the model relative to the data (Peng & So, 2002). In other words, goodness-of-fit reveals the discrepancy between observed and expected values. Two descriptive measures of goodness-of-fit are presented as R^2 indices, representing the proportion of variance *explained* by the model (Cox & Snell, 1989; Nagelkerke, 1991). The R^2 statistics utilized in this study are very similar to R^2 statistics in linear regression, measuring the amount of variance in the outcome (dependent variable) that is accounted for by the independent variables included in the model (Mertler & Vannatta, 2005). Finally, logits have been transformed back to a probability scale as follows:

$$\text{Predicted probability} = \frac{e^{\text{logistic regression equation}}}{1 + e^{\text{logistic regression equation}}}$$

Confidence intervals acknowledge the notion research models contain a set of observations designed to explain a particular phenomenon, plus some error. Confidence intervals explain the range of values in which we are confident the population mean falls (Linneman, 2014). A commonly used confidence interval is 95%, meaning the true mean of the population will fall within a set of limits 95% of the time. Put differently, a 95% confidence interval means there is a 5% chance the population mean will be outside a given range. Confidence intervals explain the range of values that are most likely to occur in a sample. In this study, 95% confidence intervals have been established to describe the range of values in which additional sample means would fall if the study were repeated.

Casewise diagnostics have been used to calculate residuals to examine how well the data fit the logistic regression model. To do so, analysis residuals were examined to identify points that unduly influence the model (Field, 2013). A summary of residual statistics is provided to determine which cases have influenced the model.

There are several key assumptions associated with the logistic regression model (Field, 2013). First, given the binary dependent variable (remediation: yes or no) applied in this study, linearity in logistic regression assumes there is a linear relationship between continuous independent variables and the binary outcome. To test this assumption, I investigated the interaction between each independent variable and the outcome. Second, independence of errors assumes observations, or cases, represent the assumption that each observation is independent. To test this assumption, I examined the dispersion parameter produced in the analysis. Lastly, multicollinearity is the assumption that independent continuous variables are independent from each other; in other words, highly correlated independent variables essentially contain the same

information and add little to the analysis (Mertler & Vannatta, 2005). To test this assumption, I utilized the tolerance measure of collinearity and variance inflation factor for each independent variable.

Role of the Researcher

I am a graduate student conducting this study as the culminating project toward doctoral degree completion (Ed.D.). In addition, I am currently employed at the ODE as the Assistant Superintendent of Assessment and Accountability. I have been a permanent employee of the ODE since February 2010, and have served in a variety of leadership roles during that time, all within the office of assessment and accountability. During my tenure at the ODE, I have been deeply involved with policy development and implementation activities associated with state testing programs and graduation requirements, in particular the essential skills of reading, writing, and math. In addition, I have testified to legislative committees, the State Board of Education, and other governing bodies regarding assessment, accountability, and graduation policies on a regular basis. As such, I have a vested interest in the findings reported in this study.

Research Ethics

George Fox University Institutional Review Board (IRB) approval is not required for this study. To obtain the required data from the ODE, I submitted a formal request to the Data Governance Committee (DGC), an internal ODE committee that reviews research related data requests to ensure the appropriateness of the study and confirm the need for requested data. Upon approval by the DGC, appropriate ODE staff produced and delivered a spreadsheet containing the requested data via secure electronic file transfer. The HECC does not utilize a data governance body akin to the DGC. To that end, I submitted a formal request to the Director of Research and Data (HECC) for remediation data at public 4-year postsecondary institutions.

Upon approval, HECC staff produced and delivered a spreadsheet containing the requested data via secure electronic file transfer.

Once the ODE and HECC data files were received, I linked the data at the student level using name, birthdate, and gender, creating a single file with all the necessary data elements (dependent and independent variables). Name and birth date were removed from the linked file, as those data elements were only necessary to establish the link, and are not relevant to the specific research questions and corresponding statistical analysis. Data is maintained securely on an encrypted external drive. No personally identifiable information has been used in the data analysis, interpretations, and conclusions of this study. I will maintain the linked file, not including name and birth date, for three years following the completion of the approved study. At that point in time, approximately May 2019, the file will be destroyed via permanent deletion from the encrypted external drive.

Potential Implications of the Research

The potential implications of this research are twofold. First, state level graduation policy decisions may be informed by the findings from this study. Most notably, the extent to which the essential skill of math has impacted public 4-year postsecondary remediation rates is important for policymakers to understand as they consider next steps in graduation policy review initiatives. Additionally, the findings from this research will provide insight regarding the efficacy of the sources of evidence students use to meet the essential skill of math graduation requirement. In other words, the comparative relationship between the sources of evidence (state test and work samples) and remediation rates will help policymakers better understand the nature and impact of establishing flexible options for students to meet minimum competency

requirements. Put simply, flexibility is meaningful if it leads to equitable outcomes for all students.

The second potential implication of this study is further review of postsecondary remediation policies and practices. As stated previously, remedial course placement policies vary significantly across Oregon public 4-year postsecondary institutions. More specifically, the assessments used to make placement decisions are determined locally. Among commonly used placement tests, data interpretation methods also vary widely from one institution to the next. In other words, a single score on one assessment could mean placement in a remedial course at one postsecondary institution, and placement in a credit-bearing course at another. The findings from this study may help inform remedial course placement policymakers by demonstrating the need for greater systems alignment, as well as alignment with high school graduation requirements.

CHAPTER 4

RESULTS

Introduction

The purpose of this study was to investigate the extent to which Oregon's essential skill of math graduation requirement has improved college academic preparedness. Using data provided by the ODE and the HECC, I employed a logistic regression model to explore the relationship between the essential skill of math graduation requirement and postsecondary remediation rates by comparing Oregon high school graduates from the classes of 2010, 2012, 2014, and 2015. In addition, I examined the various sources of allowable evidence for the essential skill of math to ascertain the degree of consistency they provide in predicting 4-year postsecondary academic preparedness. An objective of this investigation was to better understand the relationship between high school minimum proficiency requirements in math and academic preparedness at 4-year postsecondary institutions. Academic preparedness was examined using a categorical proxy variable: enrolled or did not enroll in at least one postsecondary remedial math course during the fall semester following high school graduation. In addition, I will describe the methods used to link the data sets and derive the research sample, as well as the demographic characteristics of the sample. Furthermore, I will explain the results of the logistic regression model utilized in this study. Lastly, I will discuss the results of testing key assumptions associated with the logistic regression model.

Data Linking

I submitted official data requests to the ODE and the HECC on October 12, 2015, and received final data files in Excel format on December 12, 2015. The ODE data set included all students from four school districts (16 comprehensive high schools) that graduated with a regular

high school diploma in the classes of 2010, 2012, 2014, and 2015. The ODE data set provided 20,060 records. The HECC data set included all students from the same four school districts and comprehensive high schools that graduated with a regular high school diploma in the classes of 2010, 2012, 2014, and 2015, and subsequently enrolled in coursework at any Oregon public, 4-year postsecondary institution the following fall term. The HECC data set provided 3,740 records.

Using SPSS 22.0, I created a merged data set by linking students with last name, first name, birthdate, and gender. The initial merge successfully linked 3,587 cases, a 95% match rate, leaving 153 unresolved cases. I reviewed each of the 153 cases manually to determine whether or not variation in data entry may have caused a failed link. Among unresolved cases, 149 were located with slight variations in last or first name; the predominant issue was the inclusion or exclusion of a hyphen. For example, a student may have the last name Smith-Robins in one file, and Smith-Robbins in the other. I used birthdate, gender, and high school to confirm these records did indeed represent a single student, and manually adjusted the ODE file. Finally, I merged the two data sets again and successfully linked 3,736 cases, a 99% match rate.

Once the merged data set was completed, I removed cases based on the exclusion criteria described in chapter 3. First, I removed 162 cases that did not include an essential skill of math source of evidence. Next, I removed 34 cases that did not include an OAKS math score. In addition, I removed two cases that did not include a high school GPA. Lastly, I removed 1,680 cases that did not include enrollment in one or more math courses during the fall term. It is worth noting that among the 3,736 cases in which students enrolled at public, 4-year university the following fall after high school graduation, a staggering 50% did not enroll in a math course. After removal of the cases listed above, the final sample size for this study was 1,858.

Demographic Information

Among the total sample, 51% were female and 49% were male. Historically underserved students are those self-identified as African American, Hispanic, American Indian/Alaska Native, Pacific Islander, Unknown, or Non-resident Alien. The historically underserved category represents 19% of the total sample, meaning 81% of the sample is represented by White, Asian, and students who have identified two or more races. In addition, economically disadvantaged students represented 36% of the total sample, English language learners represented 1% of the total sample, and students with disabilities represented 2% of the total sample. It is important to note that economically disadvantaged students, English language learners, and students with disabilities are not mutually exclusive categories. In other words, any particular student may be identified in any one or more of these groups, or none at all. Table 2 provides a summary of demographic counts by graduating class for the sample.

Table 2

<i>Demographic Counts by Graduating Class</i>						
Graduating Class	Gender		Historically Underserved	Economically Disadvantaged	English Language Learner	Students with Disabilities
	Female	Male				
2010	235	205	49	155	8	10
2012	230	231	87	183	5	11
2014	255	238	104	159	8	12
2015	220	244	110	171	3	6

Among historically underserved students in the sample, 51% were female and 49% were male. In addition, economically disadvantaged students were 49% female and 51% male. Although students with disabilities and English language learners represent a small percentage of the total sample, they were 69% and 63% female, respectively.

Each graduating class represented a reasonably even distribution of female and male students, the class of 2015 being the only group with more males than females (53%). Interestingly, although historically underserved students represent 19% (350) of the total sample, the percentage of historically underserved students increases with each graduating class, beginning with 11% in the class of 2010 and ending with 31% in the class of 2015.

Variables

This study utilized a logistic regression model with one bivariate dependent variable (remediation), and a variety of independent variables, both categorical and continuous in nature.

Dependent variable

Remediation is defined as enrollment in a postsecondary non-credit bearing math course under the 100 level. Table 3 summarizes postsecondary remedial and non-remedial math cases by graduating class for this sample.

Table 3

<i>Remedial and Non-remedial Math Cases by Graduating Class</i>			
High School Class	N	Remedial	Non-remedial
2010	440	95	345
2012	461	97	364
2014	493	82	411
2015	464	75	389

Independent variables

In addition to the demographic variables summarized in Table 2 above, this study utilized two categorical independent variables (high school class and essential skill of math source of evidence) and three continuous independent variables (high school GPA, SAT math score, and OAKS math score). High school classes of 2014 and 2015 were required to demonstrate proficiency in the essential skill of math in order to earn a regular high school diploma. As such,

those classes were combined and considered the treatment group, coded as 1. Students in the classes of 2010 and 2012 were combined and considered the non-treatment group, coded as 0. Students in the treatment group used one of two sources of evidence to demonstrate proficiency in the essential skill of math. The sources of evidence were either work samples (coded as 1) or the OAKS math test (coded as 0). Table 4 summarizes essential skill of math source of evidence by treatment and non-treatment group.

Table 4

Essential Skill of Math Source of Evidence by Group

Group	N	Essential Skill of Math Source of Evidence
Classes of 2010 and 2012 (non-treatment)	901	N/A
Classes of 2014 and 2015 (treatment)	957	17

Within the treatment group, only 17 students (1.8%) were reported as having utilized work samples to demonstrate proficiency in the essential skill of math to earn a regular diploma. The small number of work sample cases in this sample violates the logistic regression assumption that all combinations of variables are present (Field, 2013). As such, the essential skill source of evidence variable was removed from the model.

Three continuous independent variables were used in this study, including high school GPA, SAT math score, and OAKS math score. Table 5 provides a summary of descriptive statistics for the three continuous independent variables in the sample.

Table 5

Descriptive Statistics for High School GPA, SAT Math, and OAKS Math

	N	Min	Max	Mean	Standard Deviation
High school GPA	1858	1.98	4.32	3.52	.35
SAT math score	1535	210	800	532.7	91.1
OAKS math score	1858	213	280	243.4	7.2

The SAT and OAKS math tests are both standardized measures administered regularly in Oregon schools. The purposes of the tests vary slightly: the SAT math test is designed to predict college success (academic achievement), while the OAKS math test is designed to measure mastery of academic standards. Furthermore, the SAT math test is a norm-referenced assessment, meaning individual performance is compared to other test takers. In other words, students are sorted based on their level of achievement on the test. In contrast, the OAKS math assessment is criterion-referenced, meaning performance is compared to a pre-determined criteria or standard. Although these assessments are used for different purposes, they are similar in nature and are highly correlated ($r = .72$). Given the high degree of association between these two tests, along with the body of literature supporting the use of SAT test scores as predictors of college success, I removed the OAKS math test as a variable in the logistic regression model.

It is worth noting that one of the four school districts included in this study utilizes a weighted grade point average calculation based on a 5-point scale, as compared to the traditional high school GPA scale (0 – 4.0). Students from this district who complete 300-/400-level college courses in math, science, English, social studies, as well as Advanced Placement (AP) and International Baccalaureate (IB), receive additional credit reflected in their GPA (Bend-LaPine School District, 2014). Among the 350 students in the sample from the school district in question, 31 earned a cumulative high school GPA above 4.0. Those 31 students represented 8% of the students in the sample from the respective district, and 1.6% of the total sample, well below the threshold to be concerned that these students may influence the model. Nevertheless, discussions in chapter 5 will account for these findings.

Logistic Regression Model

The logistic regression model used in this study included a variety of categorical and continuous variables to predict remedial treatment in college math courses. There are two basic approaches to building logistic regression models, hierarchical and stepwise (Field, 2013). Hierarchical methods are preferred when building logistic regression models from a theory-driven perspective. In other words, when the predictive nature of variables is supported by previous research, it is most appropriate to include them first. In contrast, stepwise methods are used to include variables in which no previous predictive relationship has been established. Using the stepwise method, variables are added and removed based on the degree to which they improve the predictive ability of the model. Essentially, I am seeking a *parsimonious* logistic regression model, meaning one that explains the phenomenon in the simplest manner possible (Field, 2013).

Variables were entered into the logistic regression model using both hierarchical and stepwise methods. In model 1, high school GPA and SAT math scores were entered hierarchically, as they are supported in the literature as accurate predictors of college success. In model 2, I added all demographic variables using the stepwise method. Model 2 also included the treatment variable (high school class), indicating if a student was in the treatment group (classes of 2014 and 2015) or control group (classes of 2010 and 2012). As part of model 2, I included an interaction between the demographic and treatment variables to investigate the combined effect.

The overall fit of model 1 is significant, $\chi^2 = 306.74$, $p < .001$. The model accounts for 29% of the information in the dependent variable (Nagelkerke $R^2 = .294$). Demographic and treatment variables were added to build model 2 and the overall fit remains significant; $\chi^2 =$

324.81, $p < .001$; the model now explains 31% of the information in the dependent variable ($R^2 = .310$). Both models accurately predict the likelihood of remediation 83% of the time. Table 6 provides a summary of the predicted and observed remediation values for the model.

Table 6

Predicted and Observed Remediation Values

	Observed		Predicted Remediation		Percentage Correct
			No	Yes	
Model 1	Remediation	No	1206	46	96.3
		Yes	213	70	24.7
	Overall				83.1
Model 2	Remediation	No	1203	49	96.1
		Yes	216	67	23.7
	Overall				82.7

Table 6 measures predicted against observed remediation classification (Binomial Logistic Regression in SPSS, n.d.). In model 1, 83.1% of the cases are correctly classified by assuming all cases are *not* remedial and including only high school GPA and SAT math scores. In model 2, 82.7% of the cases are correctly classified when demographic variables are added. Among demographic variables, gender is the only independent variable along with high school GPA and SAT math scores that significantly predicts remedial classification. This finding will be discussed in more detail later in chapter 4. In summary, there is minimum reduction in accuracy of classification from model 1 to model 2, meaning the percentage accuracy in classification (PAC) is approximately 83%.

The percentage of observed remedial cases that were correctly predicted by the model was 23.7%. In other words, 23.7% of students in the sample were both enrolled and predicted to be enrolled in remedial math courses (true positives). The percentage of cases that did *not* include remediation which were correctly predicted by the model (true negatives) was 96.1%.

Put differently, 96.1% of students that did *not* enroll in remedial math courses were correctly predicted by the model.

As variables are added, the primary concern is the degree to which the variables *improve* the model. To do so, I examined the difference in the chi-square (χ^2) and -2 Log likelihood statistics between the models. The chi-square statistic compares observed and predicted values. As chi-square increases, the added variables are explaining more of the variance in the outcome. In this case, chi-square increased 25.26 from model 1 to model 2, indicating a significant change when demographic and treatment variables were added to the model ($p = <.001$). Conversely, the -2 Log likelihood statistic indicates the amount of variance *not* accounted for in the model. The -2 Log likelihood statistic decreased 18.06 from model 1 to model 2. Together, chi-square and -2 Log likelihood statistics indicate the extent to which additional variables explain variance, as well as the amount of variance *not* explained. In other words, the predictive ability of the model is improving if added variables concurrently increase chi-square and decrease -2 Log likelihood statistics. As demographic and treatment variables were added to the logistic regression model in this study, chi-square and -2 Log likelihood statistics increased and decreased respectively, indicating improvement in predictive ability of the model. Furthermore, the increased R^2 values from model 1 to model 2 indicate the overall fit of the model has improved with added demographic and treatment variables. Tables 7 and 8 provide summaries of the logistic regression model and coefficients.

Table 7

Summary of Logistic Regression Model

Model	Chi-square	<i>df</i>	<i>p</i>	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	306.74	2	<.001	1160.55	.181	.294
2	332.00	4	<.001	1142.49	.191	.310

Table 8

Summary of Logistic Regression Coefficients by Model

		<i>B</i>	<i>Wald</i>	<i>df</i>	<i>p</i>	Odds Ratio
Model 1	High school GPA	-.954	17.62	1	<.001	.385
	SAT math score	-.014	152.82	1	<.001	.986
	Constant	8.69	109.59	1	<.001	5935.78
Model 2	High school GPA	-1.09	21.37	1	<.001	.334
	SAT math score	-.013	129.26	1	<.001	.987
	Gender	-.336	4.39	1	.036	.714
	ES math treatment	-.567	13.97	1	<.001	.567
	Constant	9.31	117.38	1	<.001	11006.94

In model 2, demographic and treatment variables were added to the model one at a time and removed based on the likelihood ratio statistic. The likelihood ratio statistic measures the extent to which variables effect the likelihood of an outcome. In this case, demographic and treatment variables were added to high school GPA and SAT math scores (model 1) to ascertain the extent to which they would affect the likelihood of remediation. Variables indicating status as historically underserved, English language learner, economically disadvantaged, and students with disabilities did not affect the likelihood of remediation, and were removed from the model.

Individual Predictors

The logistic regression model reveals four significant predictors of remedial math course enrollment: essential skill of math graduation requirement (treatment), high school GPA, SAT math score, and gender. For each variable, negative beta values and odds ratios under 1 indicate a negative relationship between the independent variables and outcome. In other words, as independent variables increase, the likelihood of the dependent variable (remediation) occurring decreases (Mertler & Vannatta, 2005). For example, as SAT math scores and high school GPA increased by 1 unit, the likelihood of being classified in the remediation category decreased (OR = .987 and .334, respectively). In addition, students who were required to demonstrate

proficiency in the essential skill of math to earn a regular diploma (treatment) were less likely to receive math remediation (OR = .567). Lastly, female students were less likely to receive math remediation than males (OR = .714). Table 9 provides beta values and their standard errors, along with odds ratios for independent variables based on 95% confidence intervals.

Table 9

Independent Variable Coefficients Predicting Likelihood of Remediation

	<i>B</i>	95% CI for Odds Ratio		
	SE	Lower	Odds	Upper
ES math treatment	-.567* [.152]	.422	.567	.764
High school GPA	-1.09* [.237]	.210	.334	.532
SAT math score	-.013* [.001]	.985	.987	.989
Gender	-.336 [.161]	.521	.714	.979
Constant	9.31* [.859]			

Note: $R^2 = .191$ (Cox & Snell), .310 (Nagelkerke). Model $\chi^2(2)$, * $p < .001$.

Assumptions

Logistic regression, like other forms of regression, is open to sources of bias for a variety of reasons, such as sampling strategy and sample size. To address these sources of bias, I tested the key assumptions of linearity and multicollinearity. Linearity assumes there is a linear relationship between the outcome and independent variables. In this case, the outcome is bivariate (remediation: yes or no), meaning the assumption of linearity has already been violated. In logistic regression, linearity is tested by examining the relationship between any continuous variables and the logit of the outcome (Field, 2013). To do so, I created an interaction between the continuous independent variables (high school GPA and SAT math score) and their respective log transformation. The Bonferroni correction (Field, 2013) was applied based on the

number of continuous independent variables to establish an adjusted level of significance (p -value). In this case, the number of variables (2) is divided by .05, indicating $p = .025$. High school GPA ($p = .08$) and SAT math score ($p = .04$) were statistically not significant when tested for linearity. In other words, the p -values were above .025, meaning each of the two continuous independent variables possesses a linear relationship with the logit of the outcome (remediation), satisfying the assumption of linearity in the model.

Multicollinearity occurs when two or more independent variables are highly correlated, typically $r \geq .80$ (Mertler & Vannata, 2005). To test this assumption, I evaluated two collinearity statistics for each independent variable: variance inflation factor (VIF), and tolerance. VIF explains the severity of multicollinearity by providing an index of how much the variance in regression coefficients is increased as a result of collinearity. Tolerance for each variable is 1 minus the proportion of variance it shares with other independent variables in the model. Essentially, VIF is the reciprocal of tolerance (O'Brien, 2007). VIF statistics less than 10 and tolerance measures greater than .1 satisfy the assumption that independent variables do not highly correlate with other predictors. Table 10 provides a summary of collinearity statistics for each independent variable in the logistic regression model.

Table 10

<i>Collinearity Coefficients</i>		
	Tolerance	VIF
ES math treatment	.985	1.02
High school GPA	.754	1.33
SAT math score	.660	1.52
Gender	.847	1.18

In addition to linearity and multicollinearity, overdispersion must be addressed to explain whether or not observed variance in the model was greater than expected (Field, 2013). To do

so, I calculated the chi-square goodness-of-fit statistic to degrees of freedom ratio, known as the dispersion parameter. If the dispersion parameter is greater than 1, overdispersion is present. The chi-square goodness-of-fit to degrees of freedom ratio for this study is .86 (1261.35/1471), providing a clear indication that overdispersion was not present.

Finally, casewise diagnostics were performed to determine the extent to which outliers may have influenced the model. Only two cases were identified in which remediation was observed yet not predicted, based on the independent variables that best fit the model. This is well below the threshold of cases that would cause concern for negatively influencing the model.

Research Questions

Primary research question #1: Did the 2014 essential skill of math graduation requirement improve remediation rates at Oregon public 4-year postsecondary institutions? The first primary research question was designed to explore the degree to which the essential skill of math graduation requirement affected remediation rates at Oregon public 4-year postsecondary institutions. Among all students in each of the four graduating classes included in the sample, 19% enrolled in remedial math coursework, while 81% enrolled in credit-bearing math coursework. In sum, students from the classes of 2010 and 2012 experienced a 21% remediation rate, compared to students from the classes of 2014 and 2015 who experienced a remediation rate of 16%.

The odds ratio (OR) is often used in logistic regression models as a measure of association to estimate the relative likelihood of an outcome to occur for one group compared to another (Hosmer, Lemeshow, & Sturdivant, 2013). In other words, I can interpret odds ratios for a particular group by examining how far the value deviates from 1. Odds ratios above 1 indicate that as the independent variable increases, so does the likelihood of the outcome. Conversely,

odds ratios below 1 indicate that as the independent variable increases, the likelihood of the outcome decreases.

The logistic regression model used in this study revealed membership in the classes required to demonstrate proficiency in the essential skill of math significantly predicted the likelihood of remediation. More specifically, students in the classes of 2014 and 2015 were less likely to receive remediation ($OR = .567; p < .001$). The interpretation is that students in the classes of 2014 and 2015 included in this sample were 43% *less* likely to receive math remediation at public, 4-year postsecondary institutions ($1 - .57 = .43$).

Primary research question #2: What is the association between the 2014 essential skill of math sources of evidence (OAKS and work samples) and remediation rates at Oregon public 4-year postsecondary institutions? The second primary research question was designed to ascertain the association between two essential skill of math sources of evidence (OAKS and work samples) and math remediation. Among students in the treatment group ($n = 957$), only 17 were reported as having met the essential skill of math graduation requirement using work samples (1.8%). The limited number of work samples was not sufficient to create the necessary combinations with other independent variables (Field, 2013), and was therefore removed from the model. It is worth noting that among the 940 students who used the OAKS source of evidence to satisfy the essential skill of math graduation requirement, 148 (16%) received remedial treatment. In contrast, 9 out of 17 students (53%) using work samples received remedial treatment. These percentages demonstrate a significant contrast between the sources of evidence and remediation rates, however must be interpreted with caution given the small numbers and convenience nature of the sample. Table 11 summarizes remediation rates based on essential skill of math source of evidence for each demographic group.

Table 11

<i>Remediation Rates by Essential Skill of Math Source of Evidence</i>						
Source of Evidence	Gender		Historically Underserved	Economically Disadvantaged	English Language Learner*	Students with Disabilities*
	Female	Male				
OAKS	11%	21%	27%	21%	18%	25%
WS	50%	54%	67%	63%	N/A	50%

*Categories subject to significant fluctuation given sample sizes less than 10.

Primary research question #3: What is the impact of the 2014 essential skill of math on Oregon public 4-year postsecondary institution remediation rates for students from various demographic backgrounds, including male, female, historically underserved, students with disabilities, English language learners, and economically disadvantaged? The third primary research question was designed to explore the impact of the essential skill of math graduation requirement on remediation rates for students from various demographic backgrounds. Remediation rates for each student group decreased for those students in the graduating classes of 2014 and 2015, consistent with the overall improvement in remediation rates described in the first primary research question. Table 12 summarizes remediation rates for the treatment and non-treatment groups by demographics.

Table 12

<i>Remediation Rates for Treatment and Non-treatment groups by Demographics</i>						
Graduating Classes	Gender		Historically Underserved	Economically Disadvantaged	English Language Learner*	Students with Disabilities*
	Female	Male				
2010 and 2012	16%	27%	32%	25%	23%	33%
2014 and 2015	11%	22%	29%	22%	18%	28%

The logistic regression model used in this study found that all but one of the demographic variables listed above were not statistically significant in predicting the likelihood of

remediation. Gender was a significant predictor in the model ($OR = .714$; $p = .036$), indicating females were 29% *less* likely to receive math remediation.

Secondary research question #4: Among high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institutions the following fall, is there a difference in remediation rates between the classes of 2010 and 2012, and the classes of 2014 and 2015? Remediation rates by graduating class and demographics are provided in Table 13. These results show a clear improvement in remediation rates from the graduating classes of 2010 to 2015, for male, female, and economically disadvantaged students. Historically underserved students have seen slight improvement overall, after noticeable increases in remediation rates in 2012 and 2014. Remediation rates for English language learners and students with disabilities are difficult to interpret given the small number of students represented in each class ($n < 10$).

Table 13

<i>Remediation Rates by Graduating Class and Demographics</i>						
Graduating Class	Gender		Historically Underserved	Economically Disadvantaged	English Language Learner*	Students with Disabilities*
	Female	Male				
2010	16%	28%	27%	27%	25%	40%
2012	16%	26%	35%	24%	20%	27%
2014	12%	22%	32%	26%	25%	17%
2015	11%	21%	26%	19%	0	50%

As discussed in the third primary research question, gender was the only significant predictor of the likelihood of remediation in this logistic regression model.

Secondary research question #5: Among 2014 and 2015 high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institution the following fall, is there a difference in remediation rates

between those who used OAKS and work samples to meet the essential skill of math graduation requirement? The sample used in this study includes 17 cases in which work samples were identified as the source of evidence to meet the essential skill of math graduation requirement. This represents 1.8% of the total sample, and is insufficient to examine the association between sources of evidence and remediation rates. As such, the essential skill of math source of evidence variable was excluded from the logistic regression model; descriptive information for the 17 work samples included in this study is provided in primary research question #2.

Secondary research question #6: Which specific college readiness indicator has the greatest predictive power of the need for remedial coursework at Oregon public 4-year postsecondary institutions? Two college readiness indicators were included in this study, high school GPA and SAT math scores. Each of the variables was significant in predicting the likelihood of postsecondary math remediation (high school GPA, $OR = .334, p < .001$; SAT math, $OR = .987, p < .001$). As high school GPA or SAT math scores increase, the likelihood of remediation decreases. The Wald statistic is a regression coefficient used to explain the significance of a predictor to an outcome (Field, 2013). Wald statistics for high school GPA and SAT math are 21.37 and 129.26, respectively, indicating SAT Math as a more significant predictor of remediation (see Table 8). Wald statistics must be interpreted with caution, as they are subject to inflated standard errors (Field, 2013). In other words, large standard errors may indicate a statistic is not an accurate representation of the population from which it came (Field, 2013). In the case of high school GPA and SAT math scores, small standard errors were observed (see Table 9). These data confirm the interpretation that among college readiness indicators included in this study, SAT math scores are the most significant

predictors of the likelihood of math remediation.

Summary

In summary, a logistic regression was performed to explore the relationship between the essential skill of math graduation requirement, high school GPA, SAT math scores, and a variety of demographic variables with remediation rates in math courses at public, 4-year postsecondary institutions in Oregon. The logistic regression model was statistically significant, $\chi^2 = 324.81$, $p < .001$. The model explains 31% of the information in the dependent variable (Nagelkerke R^2). The model accurately predicts the likelihood of remediation 83% of the time. Four independent variables were statistically significant: essential skill of math treatment, high school GPA, SAT math score, and gender (see Table 8). Each of the four statistically significant independent variables was associated with a decreased likelihood of being classified in the math remediation category.

Remediation rates for most student groups have consistently decreased from the graduating class of 2010 through 2015. Students in the classes of 2014 and 2015 were 43% less likely to be placed in remedial math coursework. Among demographic variables included in this study, gender is the only significant predictor of remedial placement. Females were 29% less likely to be placed in remedial coursework. This study was not able to evaluate the association between essential skill of math sources of evidence and remediation rates, given the minimal number of work sample cases included in the sample. High school GPA and SAT math scores were both significant predictors of the likelihood for remediation in this study.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Introduction

This study used a logistics regression model to answer research questions designed to examine the relationship between high school minimum competency requirements in math and postsecondary remediation rates. Specifically, this study explored (a) the relationship between high school graduation requirements in math and remediation rates, (b) the association between essential skill of math sources of evidence and remediation, and (c) the effect of the essential skill of math graduation requirement on various demographic groups. In this chapter, I will summarize the findings of the study and discuss implications for practitioners. In addition, I will explain the limitations of the study and make suggestions for future research.

Summary of the Findings

Remediation rates

Evidence from this study suggests that math remediation rates in Oregon public 4-year postsecondary institutions have declined. In total, among the four graduating classes and 16 high schools included in this study, postsecondary math remediation rates have decreased from 21% to 16%. Put differently, we can observe a shift from one out of every five students enrolling in math remediation to less than two out of 10 students, over the course of a five year period. In addition, the logistic regression model used in this study revealed the essential skill of math graduation requirement (treatment) as a significant predictor of the likelihood of math remediation ($OR = .567, p < .001$). Students who were required to demonstrate proficiency in the essential skill of math were 43% *less* likely to be enrolled in math remediation. This is encouraging information, yet must be contextualized further and interpreted with caution.

Most of the research on high school graduation requirements and postsecondary remediation explores credit attainment and exit exams. The essential skill of math graduation requirement fits in neither category, as the demonstration of knowledge and skill is embedded in course content and presented through a variety of assessment options. In other words, the essential skill of math is not explicitly articulated in specific courses; rather, students can demonstrate academic proficiency in multiple settings. Furthermore, students are not required to pass standardized tests to satisfy the essential skill of math graduation requirement. Instead, options that best fit the needs of students are made available, including work samples. The essential skill of math graduation requirement is flexible in nature, by design, which may be a contributing factor to the association with improved postsecondary remediation rates. As such, the findings from this study contribute new information to the conversation about high school diploma requirements and postsecondary academic preparedness.

Two continuous independent variables were included in the logistic regression model (high school GPA and SAT math score), both of which significantly predicted the likelihood of postsecondary remedial math enrollment. These findings are consistent with previous research suggesting high school GPA (Belfield & Crosta, 2012; DesJardins & Lindsay, 2008; Kowski, 2013) and SAT scores (Kobrin, Patterson, Wiley, & Mattern, 2011) are strong predictors of postsecondary academic preparedness. Moreover, some research suggests the combination of high school GPA and SAT scores strengthens the predictive ability of the metrics (Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008; Zwick & Sklar 2005).

The experimental hypothesis for this study is the essential skill of math graduation requirement has an effect on postsecondary math remediation. In other words, the experimental hypothesis predicts a relationship between the variable and the outcome. The corresponding null

hypothesis is there is no relationship between the essential skill math requirement and math remediation. Evidence from this study supports the experimental hypothesis, and therefore a potential rejection of the null hypothesis. However, given the sampling strategy employed, there is some danger for Type I errors, which occur when the researcher believes there has been an effect, when, in fact, no effect is present. A significant result does not necessarily mean the null hypothesis is incorrect; rather, it would be more appropriate in this case to interpret the null hypothesis as highly unlikely (Field, 2013). In the context of this study, it is highly unlikely there is no relationship between the essential skill of math graduation requirement and postsecondary math remediation. Moreover, there may be additional variables contributing to improved remediation rates, which will be discussed later in this chapter.

Sources of evidence

In addition to examining the effect of the essential skill of math graduation requirement on postsecondary remediation rates, this study was designed to explore the relationship between essential skill of math sources of evidence and remediation. Unfortunately, the sample yielded too few cases in which students utilized the alternative method of work samples to satisfy the essential skill of math graduation requirement. This alone is an important finding. At the state level, 14% of the graduating class of 2014 was identified as using work samples to meet the essential skill of math graduation requirement (Oregon Department of Education, 2015b). In this study, only 1.8% of the cases denote work samples. These data appear to indicate that Oregon high school graduates attending 4-year postsecondary institutions are less likely to have met their essential skill of math graduation requirement using a work sample.

It is important to note that while work samples are an allowable source of evidence for the essential skill of math, they are also locally developed, administered, scored, and reported.

The state provides some parameters regarding content and scoring, however it is most accurate to characterize work samples as locally managed, meaning there can be some degree of variance relative to quality, security, administration protocols, and scoring practices from one school district to the next. This flexibility is designed to enable local educators to customize work samples to meet the needs of each student, although the risk of variation is that some students may be administered lower quality work samples, or have them judged by raters not appropriately calibrated to the scoring guides. Generally speaking, finding the balance between flexibility and standardization is a challenge in the assessment community. While flexibility is designed to provide increased access for students, there is also increased risk that some students will meet the graduation requirement without being truly academically prepared, or perhaps not meet the requirement at all.

Equity

Evidence from this study indicates membership in various demographic groups is not a significant predictor of the likelihood to be enrolled in postsecondary remedial math coursework. Females were 29% *less* likely to receive math remediation than males ($OR = .714; p = .036$). Students from all demographic groups who were required to meet the essential skill of math graduation requirement in this sample experienced improved remediation rates, although some more than others.

Improved remediation rates represent a positive outcome relative to the essential skill of math graduation requirement. Comparing student groups is important to better understand the extent to which this requirement leads to equitable outcomes for all students. In other words, the findings from this study suggest the essential skill of math requirement may be supporting some

students more than others. Table 14 compares remediation rates for students from each demographic to those who are not identified in the respective group.

Table 14

<i>Remediation Rate Comparison by Membership Group</i>								
Graduating Classes	Historically Underserved		Economically Disadvantaged		English Language Learner		Students with Disabilities	
	Yes	No	Yes	No	Yes	No	Yes	No
2010 and 2012	32%	20%	25%	19%	23%	21%	33%	21%
2014 and 2015	29%	13%	22%	13%	18%	16%	28%	16%

These results indicate more modest remediation rate improvement for students who are identified in each demographic group. For example, historically underserved students required to meet the essential skill of math graduation requirement experienced a 3% remediation rate improvement; however, students who were not identified as historically underserved experienced a 7% improvement. The same discrepancy exists for economically disadvantaged, while English language learners and students with disabilities appear to have experienced consistent improvement compared to other students. In sum, the essential skill of math graduation requirement is associated with improved remediation rates, although the requirement may benefit certain groups of students more than others.

Additional metrics are helpful to further contextualize and triangulate the results of this study as part of the equity discussion. For example, high school graduation and dropout rates are also connected to the essential skills and diploma requirements more broadly, as both are indicators of the effectiveness of the system to prepare students for life after high school. At the state level, aggregate high school graduation rates have steadily increased since 2010. However, when disaggregated by demographic characteristics, we can see some groups of students are

experiencing more improvement than others. Table 15 provides a summary of graduation rates by demographic groups since 2010 (Oregon Department of Education, 2015c).

Table 15

Graduation Rates by Demographic Groups

Demographic	Graduating Class		
	2010	2012	2014
All Students	66%	68%	68%
Asian	N/A	81%	85%
American Indian/Alaska Native	N/A	51%	50%
African American	50%	53%	56%
Hispanic	55%	60%	60%
White	70%	71%	70%
Female	71%	73%	72%
Male	62%	64%	64%
Economically Disadvantaged	60%	61%	60%
English Language Learners	50%	49%	45%
Students with Disabilities	42%	38%	37%

Note: Graduation rate information for the class of 2015 is not yet available.

These graduation rates show steady increases, but not for all students. In particular, students with disabilities and English language learners have experienced noticeable declines in graduation rates, while many other groups have remained flat. These data suggest the implementation of Oregon's new diploma requirements, to include the essential skills, has affected each demographic group in different ways.

Dropout rates are calculated differently than graduation rates, in that they capture all students at a given moment in time, as compared to graduation rates, which adjust as students move in and out of schools. Dropout rates are a snapshot for the percentage of students in a given year that withdrew from school and did not graduate or transfer to another school leading to graduation (Oregon Department of Education, 2015d). In other words, graduation and dropout rates are not inverse in nature. Similar to graduation rates, dropout rates have increased steadily

for most demographic groups since 2010. Table 16 summarizes dropout rates by demographic groups since the 2009-10 school year (Oregon Department of Education, 2015d).

Table 16

Dropout Rates by Demographic Groups

Demographic	School Year		
	2009-10	2011-12	2013-14
All Students	3.4%	3.4%	4.0%
Asian	1.4%	.91%	1.2%
American Indian/Alaska Native	6.7%	7.7%	6.8%
African American	6.2%	5.9%	6.0%
Hispanic	4.7%	4.5%	5.3%
White	2.9%	3.0%	3.5%
Female	2.9%	2.8%	3.3%
Male	3.8%	3.9%	4.5%
Economically Disadvantaged	2.8%	3.0%	3.8%
English Language Learners	5.9%	5.2%	7.6%
Students with Disabilities	4.6%	4.8%	6.1%

This study was not designed to explore the relationship between the essential skill of math graduation requirement and graduation or dropout rates. However, by combining these additional pieces of information with the results of this study, we can gain additional insight regarding the impact of the graduation requirement on various students. For example, generally flat or slightly increasing graduation rates may signal that the requirement has created little positive or negative aggregate impact. Increasing dropout rates for certain groups of students indicates the requirement may be a more significant barrier for some students. In other words, the same percentage of students is crossing the finish line, yet the system is losing more students from some demographic groups along the way. Relative to postsecondary math remediation rates, this study reveals similar patterns over time: improvement for all students, although some groups may be experiencing more benefit than others. In summary, the findings from this study synthesized with additional information suggest the essential skill of math graduation

requirement may differentiate support by advantaging those students matriculating to 4-year postsecondary institutions.

Implications for Practitioners

Evidence from this study suggests the essential skill of math graduation requirement is associated with improving postsecondary remediation rates. That said, the effects appear to benefit some groups of students more than others. As such, it is important for practitioners to ensure their implementation processes address the needs of all students. The essential skill of math is embedded in academic content standards, however practitioners must be diligent in providing equitable opportunities to learn for students from all demographic backgrounds. Initially, all students should be exposed to rigorous yet appropriately challenging academic content, delivered by highly qualified and effective teachers. In addition, all students should be provided multiple opportunities to demonstrate knowledge and skill, followed by timely, actionable feedback. Furthermore, all students should be afforded an array of learning supports, depending on specific needs. This does not mean providing the same supports to all students; rather, it means providing the specific supports necessary to give equitable access to learning for every student.

All students should have access to high quality assessment options to demonstrate the essential skill of math. For example, work samples must be aligned to academic content and consistent with sound instructional practice. In addition, all students should be afforded opportunities to gain a clear understanding of the expectations for their learning. This can be accomplished by using scoring guides during instruction, facilitating peer-to-peer feedback activities, communicating learning objectives, and encouraging meaningful self-reflection

throughout various learning processes. These activities are characteristic of sound assessment practice, and more importantly give students greater ownership of their learning.

In addition to the academic implications described above, practitioners are encouraged to consider the non-academic attributes of college readiness as part of the implementation of the essential skill of math graduation requirement. In addition to content knowledge and cognitive ability, many students must acquire additional learning and organizational skills in order to succeed at the college level (National Education Association, 2015; Conley, 2014, 2010, 2008, 2007a, 2007b; Skills21 at Education Connection, 2015). These skills include but are not limited to critical thinking, creativity, communication, and time management. In other words, practitioners should endeavor to cultivate a more holistic view of college readiness, going beyond academic preparedness, in order to prepare students for the rigor of credit-bearing college coursework. Although not addressed in this study, non-academic skills are just as relevant to student success in remedial courses as they are in credit-bearing courses.

Implications for Policymakers

The essential skill of math graduation requirement was designed to ensure students are better prepared for the demands of college and career. In particular, this requirement addresses issues associated with academic preparedness in college settings, helping to provide a stronger link between the Oregon high school diploma and credit-bearing college coursework (American Diploma Project, 2004). While the essential skill of math was shown to be a significant predictor of the likelihood of postsecondary remediation in this study, the extent to which the requirement has been implemented with consistency across the state remains in question. As such, policymakers are encouraged to further examine the fidelity of implementation through additional research and outreach to schools.

In particular, additional consideration must be afforded to ensure all students share the benefits of this requirement. Although most demographic variables were not shown to be significant predictors of the likelihood of postsecondary remediation, other descriptive statistics gave insight that the requirement may advantage some students more than others. This issue warrants attention from policymakers to adjust or support the requirement in different ways to ensure equitable outcomes for all students. Ultimately, proficiency in the essential skill of math is a reflection of academic content mastery. As such, policymakers might consider additional resources to support educator professional development in aligning instruction to standards and culturally responsive teaching. Regarding assessment, implementation supports could include a statewide bank of vetted, high quality work samples in both English and languages other than English. These resources should be created using universal design to ensure appropriate accessibility supports are in place for students with special learning needs. Moreover, a state assessment literacy program for teachers may help to ensure formative assessment practices are aligned to effective instructional strategies, supporting all students with clear, timely, and actionable feedback loops.

Finally, the results of this study indicate high school GPA is a significant predictor of the likelihood of postsecondary math remediation. This finding is consistent with other research suggesting the ability of high school GPA to predict college success (Kowski, 2013; Belfield & Crosta, 2012; DesJardins & Lindsay, 2008; Rothstein, 2002; Camera & Echternacht, 2000). Policymakers should consider the feasibility of including high school GPA as a source of evidence for the essential skill of math. Given the fact that work samples are locally controlled sources of evidence for the essential skill of math, allowing high school GPA would be consistent relative to honoring teacher judgment. Of course, a policy change of this nature

would require additional research and stakeholder input, although other states have set similar precedents and would likely provide a good starting point for the conversation.

Limitations of the Research

There are a number of important limitations associated with this study. First, a convenience sampling strategy was used to establish a data set for the logistic regression model. As such, the data set was not representative of the Oregon student population. Furthermore, high schools selected for this sample did not represent each region of the state. In addition to the lack of representation by geographic region and all student demographic groups, the sample also lacked sufficient essential skill of math work samples cases, removing the opportunity to examine the effect of work samples on postsecondary remediation.

The Oregon State Board of Education adopted the Common Core State Standards in 2010. Since that time, each school district has established and executed a local implementation plan with little state level governance. The result of this approach has been inconsistent implementation of the standards statewide, meaning some students are advantaged by exposure to more rigorous content, while others experience limited opportunities to learn. In other words, those students who have accessed higher level content based on the new academic standards may have a greater chance of demonstrating proficiency in the essential skill of math, regardless of the source of evidence.

Similar to the standards, implementation of the essential skill of math requirement was managed by local school leaders. As such, there can be noticeable variance in the manner by which schools implemented the requirement, particularly in the area of work sample development, administration, and scoring. This variance may affect demographic groups in different ways. Furthermore, students from various schools and regions across the state may

experience work samples differently. For example, some districts may take considerable care to score work samples with a high degree of proficiency, while others may spend little or no time calibrating to scoring rubrics. The impact of such decisions may effect some students more positively, or negatively, than others. In general, the lack of consistency relative to standards and essential skills implementation represent limitations of this study.

The primary objective of this study was to better understand the relationship between the essential skill of math graduation requirement and math remediation in public, 4-year postsecondary institutions. These universities represent only one subset of postsecondary options for high school graduates, leaving out 2-year institutions. Many high school graduates, particularly those with lower GPAs or limited access to financial aid, choose other postsecondary options to acquire the knowledge and skill necessary to begin a career. Students attending 4-year postsecondary institutions generally represent higher standardized test scores and high school GPAs. As such, the sample used in this study did not include an adequate portion of students with more modest test scores and GPAs (see Table 5). The reason for not including 2-year postsecondary institutions in the study is that they do not receive high school transcripts, meaning GPAs are not available. Regardless, sampling only those students attending 4-year universities is an important limitation of this study.

Colleges and universities define remediation in a variety of ways. These organizations establish remediation policies and practices independently (Attewell, Lavin, Domina, & Levey, 2006), making decisions based on preference, cost, and differences in student bodies (Bettinger & Long, 2004). Differences in remediation policies and practices among the seven postsecondary institutions included in this study make it challenging to measure the effect the essential skill of math on remediation rates. In other words, a student receiving remediation at

one institution may not receive remediation at a different institution. Put differently, the lack of a consistent remediation standard represents a limitation of this study.

Finally, traditional high school GPA scales are 1 – 4.0. In this study, three of the four districts utilize traditional high school GPA scales, but one does not. The district in question utilizes a 0 – 5.0 scale, as a means to credit students for college coursework completed in high school. This study sample included 31 students with a GPA above 4.0, with the highest being a 4.32. GPAs above 4.0 represent a limitation of this study, introducing potential bias against students from other districts with high GPAs that did not have the opportunity to earn GPAs greater than 4.0.

Suggestions for Future Study

This study focused on the relationship between high school minimum competency requirements in math and postsecondary remediation rates. To do so, I examined recent graduates from 16 comprehensive high schools in Oregon attending 4-year universities. Future research should explore this relationship in other postsecondary settings, most notably 2-year institutions. Community colleges offer a broad array of programs and are an attractive option for students beginning their postsecondary academic career or seeking job specific training programs. Remediation activities in community college settings are similar to those in 4-year institutions, although community colleges serve student populations with more diverse academic backgrounds. As such, it is important to better understand the effect of the essential skill of math graduation requirement in the community college setting. One limitation, as stated previously, is community colleges do not receive high school transcripts, meaning high school GPA must be accounted for in other ways.

Among postsecondary institutions, there is a great deal of variance in the implementation of remediation practices (Camara, 2013; Bettinger & Long, 2004). To better understand the effect of local policies and practices, future studies of this nature should code postsecondary institutions in the regression model to account for variance in local remediation practices and policies. In other words, the institution a student chooses to attend may in and of itself be a significant predictor of the likelihood of remediation, based on local practice. As such, categorical code values should be applied to indicate each postsecondary institution. For example, University of Oregon (1), Oregon State University (2), and so on should be applied for all seven postsecondary institutions.

Similarly, school districts and high schools included in future studies should also be coded to account for similar variance on the public education side of the partnership. Some school districts have implemented robust college- and career readiness support programs to ensure all students have access to postsecondary opportunities. Unfortunately, these programs are not consistently available across the state, meaning students in certain districts and schools are advantaged simply based on geography. Consistent with the coding approach for postsecondary institutions, future research should include categorical coding at both the district and school level to account variance in college readiness supports provided. For example, a given district would receive a categorical value (1), and each of the high schools within the district would also receive categorical values. This approach would enable future research to reveal college readiness program variance among districts, and potentially among high schools within a given district. The combination of school district, high school, and postsecondary institution coding would significantly enhance our understanding of the relationship between the essential skill of math graduation requirement and remediation.

Future research in this area should include a proportional stratified sampling strategy to ensure student group representation is consistent with state level demographic representation. This representation should include all racial groups, as well as English language learners, economically disadvantaged, and students with disabilities. In order to gain insight regarding the effect of multiple sources of evidence, future studies should include samples with sufficient data to represent alternative assessment options. To do so, high schools reporting higher percentages of work sample use for graduation purposes could be included. This issue can also be addressed by including community colleges in future research, as mentioned previously. The goal is to better understand the extent to which multiple sources of evidence leads to equitable outcomes for all students.

Conclusions

In conclusion, this study identified the essential skill of math as a significant predictor of the likelihood students would receive postsecondary math remediation. This is an exciting and noteworthy finding, yet must be tempered and explored more deeply. Among students in this sample, females were less likely to receive postsecondary math remediation. Furthermore, high school GPA and SAT math scores were significant predictors, consistent with previous research in this field. This study was limited in terms of sampling strategy, variance in local standards implementation and assessment practices, and variance in postsecondary remediation policies. Moving forward, future research should examine remediation in community colleges and further explore how local practices (high school and college) effect remediation rates.

Most importantly, the positive effects of the essential skill of math graduation requirement have not yet been fully realized by all students. Although many demographic variables in this study were not significant predictors of the likelihood of remediation,

descriptive statistics show patterns very similar in nature to other key metrics, like graduation and dropout rates. In other words, recent policy changes have proven to deliver better outcomes for most students, but not all students. Moreover, certain groups of students are experiencing greater benefit than others. In sum, the system appears to advantage those students on a trajectory to 4-year universities more than those on other paths.

The goal of policies such as the essential skill of math is improved outcomes for all students, no matter where they are from, the color of their skin, or their physical or cognitive ability. This is the central equity issue in education today: serving all students fairly, which means differentiated support for those students in greater need. The essential skill of math graduation requirement appears to have moved our system in a positive direction, however there is more work to be done to ensure all students enjoy the benefits of higher expectations.

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APPENDICES

APPENDIX A: RESEARCH AGREEMENT/DATA USE AGREEMENT (ODE)**EXHIBIT A: RESEARCH PROPOSAL**

- A. Title or Proposed Research Project:** Dissertation Research Proposal – College readiness: An examination of the relationship between high school graduation requirements in reading and postsecondary remediation rates.
- B. Research Organization Name:** Derek Brown – doctoral candidate in the Doctor of Education in Educational Leadership (Ed.D.) program at George Fox University, Newberg, Oregon.
- C. Name of Proposer and Primary Data User**
Name: Derek Brown
Title: Doctoral Candidate, George Fox University, Ed.D. program
Phone: 503-330-5874
Email: ltderekbrown@gmail.com
- D. Person authorized to obligate the Proposer contractually**
Name: Karen Buchanan, Ed.D.
Title: Professor of Education
Phone: 503-554-2884
Email: kbuchana@georgefox.edu
- E. Person to be contacted for clarification and authorized to negotiate the contract on behalf of Proposer**
Name: Derek Brown
Title: Doctoral Candidate, George Fox University, Ed.D. program
Phone: 503-330-5874
Email: ltderekbrown@gmail.com
- F. Provide a description of the research to be performed, including the research question(s) to be addressed and potential improvements or benefits to Oregon education of answering the questions; the organization sponsoring the research.**

1. Provide a description of the research to be performed:

The purpose of this study is to investigate the extent to which Oregon's essential skill of math graduation requirement has improved college academic preparedness. Specifically, the researcher will use a quantitative research design (logistic regression) to ascertain the relationship between the essential skill of math graduation requirement and postsecondary remediation rates by comparing Oregon high school graduates from the classes of 2010, 2012, 2014, and 2015. In addition, the researcher will

examine the various sources of allowable evidence for the essential skill of math to ascertain the degree of consistency they provide in predicting 4-year postsecondary academic preparedness. An objective of this investigation is to better understand the relationship between high school minimum proficiency requirements in math and academic preparedness at public 4-year postsecondary institutions.

2. The research question(s) to be addressed:

This investigation will explore three primary research questions and three secondary questions:

Primary Research Questions

1. Did the 2014 essential skill of math graduation requirement improve remediation rates at Oregon public 4-year postsecondary institutions?
2. What is the association between the 2014 essential skill of math sources of evidence (OAKS and work samples) and remediation rates at Oregon public 4-year postsecondary institutions?
3. What is the impact of the 2014 essential skill of math on Oregon public 4-year postsecondary institution remediation rates for students from various demographic backgrounds, including male, female, historically underserved, students with disabilities, English language learners, and economically disadvantaged?

Secondary Research Questions

4. Among high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institutions the following fall, is there a difference in remediation rates between the classes of 2010 and 2012, and the classes of 2014 and 2015?
5. Among 2014 and 2015 high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institution the following fall, is there a difference in remediation rates between those who used OAKS and work samples to meet the essential skill of math graduation requirement?
6. Which specific college readiness indicator has the greatest predictive power of the need for remedial coursework at Oregon public 4-year postsecondary institutions?

3. Potential improvements or benefits to Oregon education of answering the questions:

The potential implications of this research are twofold. First, state level graduation policy decisions may be informed by the findings from this study. Most notably, the extent to which the essential skill of math has impacted public 4-year postsecondary remediation rates is important for policymakers to understand as they consider next steps in graduation policy review initiatives. If the findings from this study reveal an association between the essential skill of math graduation requirement and remediation, positively or negatively, there will likely be interest in refining the policies to continue improving performance. More importantly, should the association between the essential skill of math graduation requirement and remediation rates vary among groups of students, policymakers may request additional research to examine potential equity issues and inform their decision-making process. Additionally, the findings from this research will provide insight regarding the efficacy of the sources of evidence students use to meet the essential skill of math graduation requirement. In other words, the comparative relationship between the sources of evidence (state test and work samples) and remediation rates will help policymakers better understand the nature and impact of establishing flexible options for students to meet minimum competency requirements. Put simply, flexibility is meaningful if it leads to equitable outcomes for all students.

The second potential implication of this study is further review of postsecondary remediation policies and practices. As stated previously, remedial course placement policies vary significantly across Oregon public 4-year postsecondary institutions. More specifically, the assessments used to make placement decisions are determined locally. Among commonly used placement tests, data interpretation methods also vary significantly from one institution to the next. In other words, a single score on one assessment could mean placement in a remedial course at one postsecondary institution, and placement in a credit-bearing course at another. The findings from this study may help inform remedial course placement policymakers by demonstrating the need for greater systems alignment, as well as alignment with high school graduation requirements.

4. Importance of the knowledge gained:

The knowledge gained from this study may inform policy-making in both the K-12 public education system relative to graduation and diploma requirements, (and college and career readiness more generally), as well as

the postsecondary system relative to remediation policies and practices. Given the growing need for postsecondary remediation, associated costs, and lack of agreement regarding the effectiveness of remediation, there is a clear need to better understand the relationship between high school preparation efforts and academic preparedness for credit-bearing college coursework.

G. The organization sponsoring the research: George Fox University, Newberg, Oregon

H. ODE Data to be collected

1. Data to be collected for the research:

This research study requires data from both the Oregon Department of Education (ODE) and the Higher Education Coordinating Commission (HECC). Data collected from the ODE includes personal identifiable information (first name, last name, birth date, gender) for students graduating from four large Oregon school districts in the classes of 2010, 2012, 2014, and 2015. In addition, the ODE is requested to provide best high school OAKS math score, and essential skill of math source of evidence (applies only to students in classes of 2014 and 2015) for the students listed above.

Data collected from the HECC includes personal identifiable information (first name, last name, birth date, gender, and ethnicity) for students graduating from four large Oregon school districts in the classes of 2010, 2012, 2014, and 2015 that enrolled in an Oregon public 4-year postsecondary institution the following fall. Oregon public 4-year institutions include: University of Oregon, Oregon State University, Portland State University, Oregon Institute of Technology, Eastern Oregon University, Western Oregon University, and Southern Oregon University. In addition, the HECC is requested to provide composite high school, high school GPA, SAT math score, enrolled college courses, course titles, course numbers, and course credits.

2. How the data will be analyzed:

The data will be analyzed using a logistic regression model in the Statistical Package for the Social Sciences (SPSS) 22.0. Student level identifying information described above will be used to link individual students across the two data sets (ODE and HECC), resulting in a consolidated file that includes the required data elements for each student, including name, race/ethnicity, birthdate, high school GPA, OAKS math scores, SAT math scores, remedial course title and prefix. In addition, each student record will include indicators for economically disadvantaged, English language learner, and special education, as applicable. These indicators are not mutually exclusive, meaning students may represent a combination of indicators.

Data analysis will be conducted using a logistic regression analysis. As compared to linear (simple) and multiple regression, logistic regression is used when the dependent variable is categorical rather than continuous. In this case, the dependent variable is categorical (college remediation: yes or no). Using the independent variables listed above, logistic regression is the most appropriate method to examine the extent to which these variables are associated with, or predict, remediation. If in fact remedial treatment can be predicted, logistic regression can reveal which indicators are most influential. Furthermore, logistic regression can confirm the extent to which the inclusion of each indicator increases or decreases the likelihood of the outcome (remediation). Logistic regression will also explain the relationship between the two primary sources of evidence used to satisfy the essential skill of math (OAKS or work samples) and remediation rates, while controlling for the independent variables such as high school GPA, OAKS math test score, SAT math score, essential skill of math source of evidence, ethnicity, gender, English language learner status (yes or no), special education status (yes or no), and economically disadvantaged status (yes or no).

The logistic regression model will explain the extent to which independent variables increase and decrease the likelihood of remedial treatment. For example, I can investigate the likelihood of remediation as HS GPA and OAKS math scores increase or decrease. A similar analysis can be applied to compare groups of students, as well as students using work samples compared to OAKS as the source of evidence for the essential skill of math. Odds ratios will be derived to explain the likelihood of an event occurring. Odds ratios greater than 1 indicate that as an independent variable increases, so do the odds of the outcome occurring. Conversely, odds ratios less than 1 indicate that as an independent variable increases, the odds of the outcome occurring decrease. In this study, odds ratios will describe the likelihood of remediation as independent variables increase or decrease.

3. How the analysis will be reported and to whom:

The analysis will be reported as a formal dissertation document and dissertation defense to the researcher's assigned dissertation committee at George Fox University, Newberg, Oregon.

4. The estimated time the data from ODE will be needed:

November 2, 2016.

5. The desired medium of data released from ODE (e.g., CD, secure file

transfer, etc.):

Excel spreadsheet

I. End Product(s): Formal dissertation, culminating project to complete the Doctor of Education in Educational Leadership (Ed.D.) program at George Fox University, Newberg, Oregon.

J. Research timeline:

- Formal data request to ODE – October 12, 2016 (anticipated)
- Data is delivered to researcher – November 2, 2016
- Data analysis – November/December, 2016
- Completing chapters 4 (data analysis) and 5 (conclusions) of dissertation – January, 2016
- Dissertation defense – February, 2016 (anticipated)

K. The specific data items that will be requested from Oregon Department of Education (ODE):

Among students graduating from 16 comprehensive high schools in four school districts that earned a regular diploma in the classes of 2010, 2012, 2014, and 2015, the researcher is requesting the following data elements:

1. First name
2. Last name
3. Birth date
4. Gender
5. Best (highest) high school OAKS math scale score
6. Essential skill of math source of evidence
 - Include only “state test” and “work sample”
7. Economically disadvantaged (yes or no)
8. English language learner (yes or no)
9. Special education (yes or no)

The 16 comprehensive high schools and corresponding institution identification numbers are:

Salem-Keizer School District

1. McKay High School – 771
2. McNary High School – 772
3. North Salem High School – 773
4. Sprague High School – 774
5. South Salem High School – 775
6. West Salem High School – 3463

Bend-LaPine School District

1. Bend High School – 251
2. LaPine High School – 253
3. Mountain View High School – 252
4. Summit School – 3216

Hillsboro School District

1. Hillsboro High School – 1201
2. Century High School – 1368
3. Glencoe High School – 1200
4. Liberty High School – 4018

Medford School District

1. North Medford High School – 424
2. South Medford High School – 423

L. Data security arrangements - Provide a detailed description of how the data will be kept secure, including computer security, physical handling and storage of data, and transportation of data.

Data will be stored on an encrypted external drive at the researcher's personal residence. Data will be analyzed using an agency issued laptop computer, all data will be stored on the encrypted external drive, which will be unplugged and locked in a file cabinet when not in use. Data will not be stored or analyzed on any other devices, including laptops or tablets. Three files will be stored on the external hard drive, including the data requested files from ODE and HECC, as well as the consolidated file created by the researcher. Personal identifiable information used to link the files, including first name, last name, birth date, and gender, will be deleted from the consolidated file. These files will be maintained securely on the encrypted external drive in a locked file cabinet for three years from completion of the approved study. At that point in time, approximately May 2019, the files will be destroyed via permanent deletion from the encrypted external drive.

RESEARCH AGREEMENT / DATA USE AGREEMENT
EXHIBIT B: RESEARCH PROJECT CONFIDENTIALITY AGREEMENT

This Agreement shall be submitted with Research Proposal and shall be attached to resulting Agreement.

WHEREAS, The Agency has collected certain data containing confidential & personally-identifiable information and ODE requires this confidentiality to be protected; and

WHEREAS, The Agency is willing to make these data available for research and analysis purposes to improve instruction in public elementary and secondary schools, but only if the data are used and protected in accordance with the terms stated in this Agreement.

NOW, THEREFORE, it is hereby agreed between Agency and Researcher that:

I. INFORMATION SUBJECT TO THIS AGREEMENT

- A. All data containing personally-identifiable information collected by or on behalf of Agency provided to the Researcher and all information derived from those data, and all data resulting from merges, matches, or other uses of the data provided by Agency with other data are subject to this Agreement and are referred to herein as the subject data. The subject data under this Agreement may be provided in various forms included but not limited to written or printed documents, computer tapes, diskettes, CD-ROMs, or encrypted files.
- B. The Researcher must only use the subject data only for the purposes stated in its Research Proposal and Interagency Research Agreement.

II. INDIVIDUALS WHO MAY HAVE ACCESS TO SUBJECT DATA

Researcher agrees to limit and restrict access to the subject data to the following three categories of individuals:

- A. The Researcher in charge of the day-to-day operations of the research and who is the research liaison with Agency.
- B. The Research team in carrying of the research under this Agreement.
- C. Support staff including secretaries, typist, computer technicians, etc., only to the degree necessary to support the research.

III. LIMITATIONS ON DISCLOSURE

- A. Researcher must not use or disclose the subject data for any purpose not expressly stated in the Research Proposal approved by Agency, unless Researcher has obtained written approval in advance from the Agency's Administrator.
- B. Researcher may publish the result, analysis, or other information developed as a result of any research, based on the subject data made available under this Agreement only in summary or aggregate form, ensuring the identities of individuals included in the subject data are not revealed.
- C. Researcher must get prior written approval before releasing any documents - see paragraph IV.B.2, Administrative Requirements.

IV. ADMINISTRATIVE REQUIREMENTS

- A. The research conducted under this Agreement shall be limited to that described in “the Work”, Exhibit A. and consistent with, the purposes stated in the approved Research Proposal,
- B. Notice and training on confidentiality and nondisclosure.
 - 1. Researcher must notify and train each of its research team members who has access to the subject data of the strict confidentiality of such data, and must require each of those research team members to execute an Individual’s of Confidentiality Agreement (see Exhibit C).
 - 2. Researcher must maintain each executed Individuals of Confidentiality Agreement at its facility and must provide Agency’s Administrator a copy of each Individuals of Confidentiality Agreement signed by its research staff prior to Project start date. If Researcher wants to add staff after the Project starts date, Researcher must get written approval from Agency’s Administrator prior to staff commencing work. Agency’s Administrator shall work with Intellectual Technology (IT) Change Review Board or Data Governance Committee to approve additional staff.
 - 3. Researcher must promptly notify Agency’s Administrator in writing when the access to the subject data by any individual is terminated, giving the date of the termination and the reason for the termination.
- C. Publications made available to Agency.
 - 1. Agency’s Administrator must be given the opportunity to review Researcher’s reports prior to Researcher releasing or publishing research documentation. Copies of each proposed publication or document containing or based upon the subject data must be provided to Agency’s Agreement Administrator before the publication or document is finalized. Agency’s Administrator will advise the Researcher whether revisions are requested in order to protect confidential information. In cases where specific districts or schools within a district are publicized in the research results the proposed publication or document will also be sent to the related district. Agency’s Agreement Administrator will include responses from affected districts in their decision to authorize disclosure.
 - 2. Researcher must provide Agency’s Administrator two (2) copies of each publication containing information based on the subject data or other data product based on the subject data made available through Agency. One (1) copy must be retained by Agency’s Administrator and one (1) copy must be provided to the IT Change Review Board or DGC.
- D. Researcher must notify Agency’s Administrator immediately in writing upon receipt of any request or demand for disclosure of the subject data.
- E. Researcher must notify Agency’s Administrator immediately in writing upon discovering any breach or suspected breach, of security, of any disclosure of subject data to an unauthorized party or agency.

V. CRITERIA FOR RELEASE OF CONFIDENTIAL INFORMATION

- A. Personally-identifiable student data held at the Agency will be released for research purposes only after the following factors have been considered:
 - 1. The degree to which the research may improve Oregon public elementary and secondary education;
 - 2. The degree to which the research question(s) cannot be answered without the personally identifiable data;
 - 3. The experience of the requesting Research Organization in performing similar research projects and to conduct the proposed research project;
 - 4. The capacity of the requesting Research Organization to keep the data secure; and
 - 5. The availability of Agency staff to fulfill the data request for the research project and monitor the research activities.
- B. Such data will not be released unless the data are requested by an organization that has:
 - 1. Developed a Research Proposal approved by the IT Change Review Board or DGC,
 - 2. Completed an Individual's of Confidentially Agreement for each research team member working on the Research Project,
 - 3. An executed Research Agreement with Agency.

VI. SECURITY REQUIREMENTS

- A. Maintenance or, and access to, the subject data
 - 1. Data must be released to individuals Identified in accordance with paragraph II. Agency will annotate on Individual(s) form -Appendix C, Individuals Confidentiality Agreement, all data and equipment issued to individual by Agency for control record. Agency will provide data for research as approved by IT Change Review Board or DGC. The subject data must not be copied and an extract of the subject data must not be made available to anyone without written approval from either the IT Change Review Board DGC.
 - 2. Researcher must maintain the subject data in an area which has access limited to authorized personnel only. Researcher must not permit removal of any subject data from the limited access area.
 - 3. Researcher must NOT transmit any confidential data provided by Agency via email.
 - 4. Researcher must ensure access to the subject date maintained in computer files or databases is controlled by password protection. Researcher must maintain all printouts, disks/CD's, or other physical products containing individually-identifiable

information derived from subject data in locked cabinets, file drawers, or other secure locations when not in use.

5. Researcher must ensure all printouts, tabulations, and reports are edited for any possible disclosure of personally-identifiable subject data unless Researcher has obtained prior written approval to allow authorized individual(s) to view data.
6. Researcher must establish procedure, to ensure the subject data cannot be extracted from computer file or database by unauthorized individual(s).
7. No personally owned computers are allowed to access or store subject data or results.

B. Retention of subject data.

1. In the event of termination or expiration of this Agreement Researcher must, unless otherwise authorized in writing;
2. Immediately cease the use of the Agency data which Researcher holds or for which is responsible;
3. Within ten (10) days from date of Agreement termination or expiration, destroy all Agency data which Researcher holds or for which they are responsible by using the methods described in NIST SP 800-88 rev.1, which provides instructions for successfully clearing, purging, or destroying data on various media types;
4. Return all Agency data to Agency Helpdesk and;
5. Provide, at Agency request, a written statement Researcher and its research team no longer holds any Agency data obtained during the term of the Agreement.

RESEARCH AGREEMENT/DATA USE AGREEMENT
EXHIBIT C: INDIVIDUAL'S CONFIDENTIALITY AGREEMENT

Submit this form with Research Proposal for each staff member working on resulting Agreement.

I, _____ hereby acknowledge I may be given access to confidential personally-identifiable information as part of this Oregon Department of Education supported Research Project and I hereby agree I cannot:

1. Use, reveal, or in any other manner disclose any personally-identifiable information furnished, acquired, retrieved, derived, or assembled by me or others for any purpose other than those purposes specified in the Research Proposal Application for this Research Project, or
2. Make any disclosure whereby an individual could be identified, or the data related to any particular individual be identified.

I also pledge to adhere to all data security guidelines applicable to this Research Project. I understand I am subject to legal action for disclosure of this information to any unauthorized person or agency.

Researcher's Signature: _____

Printed Name: _____

Title: _____

Organization: _____

Date: _____

Research Project: _____

APPENDIX B: RESEARCH AGREEMENT/DATA USE AGREEMENT (HECC)**EXHIBIT A: RESEARCH PROPOSAL**

- A. Title or Proposed Research Project:** Dissertation Research Proposal – College readiness: An examination of the relationship between high school graduation requirements in reading and postsecondary remediation rates.
- B. Research Organization Name:** Derek Brown – doctoral candidate in the Doctor of Education in Educational Leadership (Ed.D.) program at George Fox University, Newberg, Oregon.
- C. Name of Proposer and Primary Data User**
Name: Derek Brown
Title: Doctoral Candidate, George Fox University, Ed.D. program
Phone: 503-330-5874
Email: ltderekbrown@gmail.com
- D. Person authorized to obligate the Proposer contractually**
Name: Karen Buchanan, Ed.D.
Title: Professor of Education
Phone: 503-554-2884
Email: kbuchana@georgefox.edu
- E. Person to be contacted for clarification and authorized to negotiate the contract on behalf of Proposer**
Name: Derek Brown
Title: Doctoral Candidate, George Fox University, Ed.D. program
Phone: 503-330-5874
Email: ltderekbrown@gmail.com
- F. Provide a description of the research to be performed, including the research question(s) to be addressed and potential improvements or benefits to Oregon education of answering the questions; the organization sponsoring the research.**

1. Provide a description of the research to be performed:

The purpose of this study is to investigate the extent to which Oregon's essential skill of math graduation requirement has improved college academic preparedness. Specifically, the researcher will use a quantitative research design (logistic regression) to ascertain the relationship between the essential skill of math graduation requirement and postsecondary remediation rates by comparing Oregon high school graduates from the classes of 2010, 2012, 2014, and 2015. In addition, the researcher will examine the various sources of allowable evidence for the essential skill of

math to ascertain the degree of consistency they provide in predicting 4-year postsecondary academic preparedness. An objective of this investigation is to better understand the relationship between high school minimum proficiency requirements in math and academic preparedness at public 4-year postsecondary institutions.

2. The research question(s) to be addressed:

This investigation will explore three primary research questions and three secondary questions:

Primary Research Questions

1. Did the 2014 essential skill of math graduation requirement improve remediation rates at Oregon public 4-year postsecondary institutions?
2. What is the association between the 2014 essential skill of math sources of evidence (OAKS and work samples) and remediation rates at Oregon public 4-year postsecondary institutions?
3. What is the impact of the 2014 essential skill of math on Oregon public 4-year postsecondary institution remediation rates for students from various demographic backgrounds, including male, female, historically underserved, students with disabilities, English language learners, and economically disadvantaged?

Secondary Research Questions

4. Among high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institutions the following fall, is there a difference in remediation rates between the classes of 2010 and 2012, and the classes of 2014 and 2015?
5. Among 2014 and 2015 high school graduates from four large Oregon school districts who entered an Oregon public 4-year postsecondary institution the following fall, is there a difference in remediation rates between those who used OAKS and work samples to meet the essential skill of math graduation requirement?
6. Which specific college readiness indicator has the greatest predictive power of the need for remedial coursework at Oregon public 4-year postsecondary institutions?

3. Potential Improvements or benefits to Oregon education of answering the questions:

The potential implications of this research are twofold. First, state level graduation policy decisions may be informed by the findings from this study. Most notably, the extent to which the essential skill of math has impacted public 4-year postsecondary remediation rates is important for policymakers to understand as they consider next steps in graduation policy review initiatives. If the findings from this study reveal an association between the essential skill of math graduation requirement and remediation, positively or negatively, there will likely be interest in refining the policies to continue improving performance. More importantly, should the association between the essential skill of math graduation requirement and remediation rates vary among groups of students, policymakers may request additional research to examine potential equity issues and inform their decision-making process. Additionally, the findings from this research will provide insight regarding the efficacy of the sources of evidence students use to meet the essential skill of math graduation requirement. In other words, the comparative relationship between the sources of evidence (state test and work samples) and remediation rates will help policymakers better understand the nature and impact of establishing flexible options for students to meet minimum competency requirements. Put simply, flexibility is meaningful if it leads to equitable outcomes for all students.

The second potential implication of this study is further review of postsecondary remediation policies and practices. As stated previously, remedial course placement policies vary significantly across Oregon public 4-year postsecondary institutions. More specifically, the assessments used to make placement decisions are determined locally. Among commonly used placement tests, data interpretation methods also vary significantly from one institution to the next. In other words, a single score on one assessment could mean placement in a remedial course at one postsecondary institution, and placement in a credit-bearing course at another. The findings from this study may help inform remedial course placement policymakers by demonstrating the need for greater systems alignment, as well as alignment with high school graduation requirements.

4. Importance of the knowledge gained:

The knowledge gained from this study may inform policy making in both the K-12 public education system relative to graduation and diploma requirements, (and college and career readiness more generally), as well as the postsecondary system relative to remediation policies and practices. Given the growing need for postsecondary remediation, associated costs, and lack of agreement regarding the effectiveness of remediation, there is a clear

need to better understand the relationship between high school preparation efforts and academic preparedness for credit-bearing college coursework.

G. The organization sponsoring the research: George Fox University, Newberg, Oregon

H. HECC Data to be collected

6. Data to be collected for the research:

This research study requires data from both the Oregon Department of Education (ODE) and the Higher Education Coordinating Commission (HECC). Data collected from the HECC includes personal identifiable information (first name, last name, birth date, gender, and ethnicity) for students graduating from four large Oregon school districts in the classes of 2010, 2012, 2014, and 2015 that enrolled in an Oregon public 4-year postsecondary institution the following fall. Oregon public 4-year institutions include: University of Oregon, Oregon State University, Portland State University, Oregon Institute of Technology, Eastern Oregon University, Western Oregon University, and Southern Oregon University. In addition, the HECC is requested to provide composite high school, high school GPA, SAT math score, enrolled college courses, course titles, course numbers, and course credits.

Data collected from the ODE includes personal identifiable information (first name, last name, birth date, gender) for students graduating from four large Oregon school districts in the classes of 2010, 2012, 2014, and 2015. In addition, the ODE is requested to provide best high school OAKS math score, and essential skill of math source of evidence (applies only to students in classes of 2014 and 2015) for the students listed above.

7. How the data will be analyzed:

The data will be analyzed using a logistic regression model in the Statistical Package for the Social Sciences (SPSS) 22.0. Student level identifying information described above will be used to link individual students across the two data sets (ODE and HECC), resulting in a consolidated file that includes the required data elements for each student, including name, race/ethnicity, birthdate, high school GPA, OAKS math scores, SAT math scores, remedial course title and prefix. In addition, each student record will include indicators for economically disadvantaged, English language learner, and special education, as applicable. These indicators are not mutually exclusive, meaning students may represent a combination of indicators.

Data analysis will be conducted using a logistic regression analysis. As compared to linear (simple) and multiple regression, logistic regression is used when the dependent variable is categorical rather than continuous. In this case, the dependent variable is categorical (college remediation: yes or no). Using the independent variables listed above, logistic regression is the most appropriate method to examine the extent to which these variables are associated with, or predict, remediation. If in fact remedial treatment can be predicted, logistic regression can reveal which indicators are most influential. Furthermore, logistic regression can confirm the extent to which the inclusion of each indicator increases or decreases the likelihood of the outcome (remediation). Logistic regression will also explain the relationship between the two primary sources of evidence used to satisfy the essential skill of math (OAKS or work samples) and remediation rates, while controlling for the independent variables such as high school GPA, OAKS math test score, SAT math score, essential skill of math source of evidence, ethnicity, gender, English language learner status (yes or no), special education status (yes or no), and economically disadvantaged status (yes or no).

The logistic regression model will explain the extent to which independent variables increase and decrease the likelihood of remedial treatment. For example, I can investigate the likelihood of remediation as HS GPA and OAKS math scores increase or decrease. A similar analysis can be applied to compare groups of students, as well as students using work samples compared to OAKS as the source of evidence for the essential skill of math. Odds ratios will be derived to explain the likelihood of an event occurring. Odds ratios greater than 1 indicate that as an independent variable increases, so do the odds of the outcome occurring. Conversely, odds ratios less than 1 indicate that as an independent variable increases, the odds of the outcome occurring decrease. In this study, odds ratios will describe the likelihood of remediation as independent variables increase or decrease.

8. How the analysis will be reported and to whom:

The analysis will be reported as a formal dissertation to the researcher's assigned dissertation committee at George Fox University, Newberg, Oregon.

9. The estimated time the data from HECC will be needed:

November 2, 2016.

10. The desired medium of data released from HECC (e.g., CD, secure file

transfer, etc.):

Excel spreadsheet, transferred to encrypted external drive.

- I. End Product(s):** Formal dissertation, culminating project to complete the Doctor of Education in Educational Leadership (Ed.D.) program at George Fox University, Newberg, Oregon.

J. Research timeline:

- Formal data request to ODE – October 12, 2016 (anticipated)
- Data is delivered to researcher – November 2, 2016
- Data analysis – November/December, 2016
- Completing chapters 4 (data analysis) and 5 (conclusions) of dissertation – January, 2016
- Dissertation defense – February, 2016 (anticipated)

K. The specific data items that will be requested from the Higher Education Coordinating Commission (HECC):

Among students graduating from 16 comprehensive high schools in four school districts that earned a regular diploma in the classes of 2010, 2012, 2014, and 2015, the researcher is requesting the following data elements:

1. First name
2. Last name
3. Birth date
4. Gender
5. Ethnicity
 - Include ethnicity type: H – Hispanic, A – Asian, P – Pacific Islander, B – Black, I – American Indian/Alaska Native, W – White, AI – Asian or Pacific Islander, U – Unknown, T – Two or more races, Z – Non-resident Alien
6. High school
7. High school composite GPA
8. SAT math score
9. Enrolled college courses for the fall term
10. Course titles
11. Course numbers
12. Course credits

The 16 comprehensive high schools and corresponding institution identification numbers are:

Salem-Keizer School District

1. McKay High School – 771
2. McNary High School – 772

3. North Salem High School – 773
4. Sprague High School – 774
5. South Salem High School – 775
6. West Salem High School – 3463

Bend-LaPine School District

1. Bend High School – 251
2. LaPine High School – 253
3. Mountain View High School – 252
4. Summit School – 3216

Hillsboro School District

1. Hillsboro High School – 1201
2. Century High School – 1368
3. Glencoe High School – 1200
4. Liberty High School – 4018

Medford School District

1. North Medford High School – 424
2. South Medford High School – 423

The seven Oregon public 4-year postsecondary institutions are:

1. University of Oregon
2. Oregon State University
3. Portland State University
4. Eastern Oregon University
5. Western Oregon University
6. Southern Oregon University
7. Oregon Institute of Technology

L. Data security arrangements - Provide a detailed description of how the data will be kept secure, including computer security, physical handling and storage of data, and transportation of data.

Data will be stored on an encrypted external drive at the researcher's personal residence. Data will be analyzed using an agency issued laptop computer, all data will be stored on the encrypted external drive, which will be unplugged and locked in a file cabinet when not in use. Data will not be stored or analyzed on any other devices, including laptops or tablets. Three files will be stored on the external hard drive, including the data requested files from ODE and HECC, as well as the consolidated file created by the researcher. Personal identifiable information used to link the files, including first name, last name, birth date, and gender, will be deleted from the consolidated file. These files will be maintained securely on the encrypted external drive in a locked file cabinet for three years from completion of the

approved study. At that point in time, approximately May 2019, the files will be destroyed via permanent deletion from the encrypted external drive.

RESEARCH AGREEMENT / DATA USE AGREEMENT**EXHIBIT B: RESEARCH PROJECT CONFIDENTIALITY AGREEMENT**

This Agreement shall be submitted with Research Proposal and shall be attached to resulting Agreement.

WHEREAS, The Agency has collected certain data containing confidential & personally-identifiable information and HECC requires this confidentiality to be protected; and

WHEREAS, The Agency is willing to make these data available for research and analysis purposes to improve instruction in public elementary and secondary schools, but only if the data are used and protected in accordance with the terms stated in this Agreement.

NOW, THEREFORE, it is hereby agreed between Agency and Researcher that:

I. INFORMATION SUBJECT TO THIS AGREEMENT

- A. All data containing personally-identifiable information collected by or on behalf of Agency provided to the Researcher and all information derived from those data, and all data resulting from merges, matches, or other uses of the data provided by Agency with other data are subject to this Agreement and are referred to herein as the subject data. The subject data under this Agreement may be provided in various forms included but not limited to written or printed documents, computer tapes, diskettes, CD-ROMs, or encrypted files.
- B. The Researcher must only use the subject data only for the purposes stated in its Research Proposal and Interagency Research Agreement.

II. INDIVIDUALS WHO MAY HAVE ACCESS TO SUBJECT DATA

Researcher agrees to limit and restrict access to the subject data to the following three categories of individuals:

- A. The Researcher in charge of the day-to-day operations of the research and who is the research liaison with Agency.
- B. The Research team in carrying of the research under this Agreement.
- C. Support staff including secretaries, typist, computer technicians, etc., only to the degree necessary to support the research.

III. LIMITATIONS ON DISCLOSURE

- A. Researcher must not use or disclose the subject data for any purpose not expressly stated in the Research Proposal approved by Agency, unless Researcher has obtained written approval in advance from the Agency's Administrator.
- B. Researcher may publish the result, analysis, or other information developed as a result of any research, based on the subject data made available under this Agreement only in summary or aggregate form, ensuring the identities of individuals included in the subject data are not revealed.
- C. Researcher must get prior written approval before releasing any documents - see paragraph IV.B.2, Administrative Requirements.

IV. ADMINISTRATIVE REQUIREMENTS

- A. The research conducted under this Agreement shall be limited to that described in “the Work”, Exhibit A. and consistent with, the purposes stated in the approved Research Proposal,
- B. Notice and training on confidentiality and nondisclosure.
 - 1. Researcher must notify and train each of its research team members who has access to the subject data of the strict confidentiality of such data, and must require each of those research team members to execute an Individual’s of Confidentiality Agreement (see Exhibit C).
 - 2. Researcher must maintain each executed Individuals of Confidentiality Agreement at its facility and must provide Agency’s Administrator a copy of each Individuals of Confidentiality Agreement signed by its research staff prior to Project start date. If Researcher wants to add staff after the Project starts date, Researcher must get written approval from Agency’s Administrator prior to staff commencing work.
 - 3. Researcher must promptly notify Agency’s Administrator in writing when the access to the subject data by any individual is terminated, giving the date of the termination and the reason for the termination.
- C. Publications made available to Agency.
 - 1. Agency’s Administrator must be given the opportunity to review Researcher’s reports prior to Researcher releasing or publishing research documentation. Copies of each proposed publication or document containing or based upon the subject data must be provided to Agency’s Agreement Administrator before the publication or document is finalized. Agency’s Administrator will advise the Researcher whether revisions are requested in order to protect confidential information. In cases where specific districts or schools within a district are publicized in the research results the proposed publication or document will also be sent to the related district. Agency’s Agreement Administrator will include responses from affected districts in their decision to authorize disclosure.
 - 2. Researcher must provide Agency’s Administrator two (2) copies of each publication containing information based on the subject data or other data product based on the subject data made available through Agency. One (1) copy must be retained by Agency’s Administrator and one (1) copy must be provided to the IT Change Review Board or DGC.
- D. Researcher must notify Agency’s Administrator immediately in writing upon receipt of any request or demand for disclosure of the subject data.
- E. Researcher must notify Agency’s Administrator immediately in writing upon discovering any breach or suspected breach, of security, of any disclosure of subject data to an unauthorized party or agency.

V. CRITERIA FOR RELEASE OF CONFIDENTIAL INFORMATION

- A. Personally-identifiable student data held at the Agency will be released for research purposes only after the following factors have been considered:
1. The degree to which the research may improve Oregon public elementary and secondary education;
 2. The degree to which the research question(s) cannot be answered without the personally identifiable data;
 3. The experience of the requesting Research Organization in performing similar research projects and to conduct the proposed research project;
 4. The capacity of the requesting Research Organization to keep the data secure; and
 5. The availability of Agency staff to fulfill the data request for the research project and monitor the research activities.

VI. SECURITY REQUIREMENTS

- A. Maintenance or, and access to, the subject data
1. Data must be released to individuals Identified in accordance with paragraph II. Agency will annotate on Individual(s) form -Appendix C, Individuals Confidentiality Agreement, all data and equipment issued to individual by Agency for control record.
 2. Researcher must maintain the subject data in an area which has access limited to authorized personnel only. Researcher must not permit removal of any subject data from the limited access area.
 3. Researcher must NOT transmit any confidential data provided by Agency via email.
 4. Researcher must ensure access to the subject data maintained in computer files or databases is controlled by password protection. Researcher must maintain all printouts, disks/CD's, or other physical products containing individually-identifiable information derived from subject data in locked cabinets, file drawers, or other secure locations when not in use.
 5. Researcher must ensure all printouts, tabulations, and reports are edited for any possible disclosure of personally-identifiable subject data unless Researcher has obtained prior written approval to allow authorized individual(s) to view data.
 6. Researcher must establish procedure, to ensure the subject data cannot be extracted from computer file or database by unauthorized individual(s).
 7. No personally owned computers are allowed to access or store subject data or results.
- B. Retention of subject data.

1. In the event of termination or expiration of this Agreement Researcher must, unless otherwise authorized in writing;
2. Immediately cease the use of the Agency data which Researcher holds or for which is responsible;
3. Within ten (10) days from date of Agreement termination or expiration, destroy all Agency data which Researcher holds or for which they are responsible by using the methods described in NIST SP 800-88 rev.1, which provides instructions for successfully clearing, purging, or destroying data on various media types;
4. Return all Agency data to Agency Helpdesk, and;
5. Provide, at Agency request, a written statement Researcher and its research team no longer holds any Agency data obtained during the term of the Agreement.

RESEARCH AGREEMENT / DATA USE AGREEMENT**EXHIBIT C: INDIVIDUAL'S CONFIDENTIALITY AGREEMENT**

Submit this form with Research Proposal for each staff member working on resulting Agreement.

I, _____ hereby acknowledge I may be given access to confidential personally-identifiable information as part of this Higher Education Coordinating Commission supported Research Project and I hereby agree I cannot:

1. Use, reveal, or in any other manner disclose any personally-identifiable information furnished, acquired, retrieved, derived, or assembled by me or others for any purpose other than those purposes specified in the Research Proposal Application for this Research Project, or
2. Make any disclosure whereby an individual could be identified, or the data related to any particular individual be identified.

I also pledge to adhere to all data security guidelines applicable to this Research Project. I understand I am subject to legal action for disclosure of this information to any unauthorized person or agency.

Researcher's Signature: _____

Printed Name: _____

Title: _____

Organization: _____

Date: _____

Research Project: _____