DESEGREGATION IN AN ERA OF RESEGREGATION: HOW HETEROGENEOUS SECONDARY SCIENCE CLASSES INCREASE STUDENT ACHIEVEMENT AND ENTRANCE INTO THE STEM PIPELINE

by

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Abstract

African American students are underrepresented in high-level secondary science courses that preclude them from pursuing post-secondary science, technology, engineering, and mathematics (STEM) degrees and careers. A significant factor associated with this problem is the institutionalized organization of secondary curriculum and instruction that disproportionately tracks or groups students of color into lower-level courses. African American students are disproportionately placed into lower-level science courses where they receive an inequitable opportunity to learn. A mixed methods design was used in which both qualitative and quantitative data were embedded within a major design intervention trial to address the negative effects caused by ability grouping in science by measuring the effect of heterogeneous chemistry classes on student achievement, self-efficacy, engagement, and interest in science. Findings revealed that regardless of course recommendation, initial achievement levels, and race, initially lower and higher achieving students enrolled in high-level heterogeneous science classes outperform their peers in traditionally grouped course levels and have higher levels of self-efficacy. Findings suggest that teacher professional development in the areas of differentiated instruction, mindset, and self-efficacy are important factors contributing to the success of students in heterogeneous classes.

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List of Abbreviations

ANOVA…… Analysis of Variance
AP…………. Advanced Placement
FARMS.…… Free and Reduced Meals
GPA……….. Grade Point Average
NGSS……… Next Generation Science Standards
NSF……….. National Science Foundation
MapM……… Measures of Academic Progress in Math
MapR……… Measures of Academic Progress in Reading
MSA………. Middle School State Assessment
PSAT……… Preliminary Scholastic Aptitude Test
PTSA……… Parent-Teacher-Student Association
STEM……… Science Technology Engineering and Mathematics

Executive Summary

African American secondary school students are disproportionately underrepresented in higher-level STEM courses precluding them from pursing post-secondary degrees and careers in STEM. At one high school located in the Mid-Atlantic United States, African American students make up 27 percent of the school population yet 47 percent of enrollments in lower-level science classes are African American students compared to 18 percent Caucasian students. This dissertation, *Desegregation in an Era of Resegregation: How Heterogeneous Secondary Science Classes Increase Student Achievement and Entrance Into the STEM Pipeline*, examines the root cause of the disparity between African American and Caucasian student enrollment in high-level secondary STEM classes and evaluates an intervention designed with the intent to help solve the problem.

Chapter One

Chapter one introduces the problem of practice by identifying an economic and social imperative for all students to have access to challenging secondary coursework in STEM. Through research, national statistics, and a historical lens, the chapter explains that researchers and practitioners are deeply concerned about the disparities between African American and Caucasian students' enrollment in high-level STEM courses. A significant factor associated with the problem is the sorting of students into different course levels, also known as "ability grouping." Researchers have discovered that ability grouping creates significant inequities in educational outcomes for students, especially for minority students. This dissertation investigates the possible negative effects of ability grouping by creating heterogeneous secondary school science classes with the intent to increase overall student achievement and subsequent access to the STEM pipeline.

Chapter Two

Chapter two provides a literature review on ability grouping and tracking. The purpose of the literature review is to (1) present a theoretical framework for this study; (2) examine the current literature on how secondary schools sort students into different curricular tracks; (3) identify the effects of those practices on students' preparation to pursue STEM in post-secondary institutions; and (4) explain how sorting students into different ability levels has persisted despite a lack of empirical support. The research presented reflects several different perspectives and represents examples of both qualitative and quantitative methodologies. Three conceptual constructs emerge from existing literature identifying how secondary schools group students into course levels and how this grouping affects students' entrance and persistence in the STEM pipeline. First, students' entrance into the STEM pipeline is examined to further define the problem with ability grouping as it relates to STEM. Second, quantitative and qualitative data describing African American students' decreased opportunity to learn in lower-level courses is reviewed and analyzed. Third, the organizational structures, processes, and practices that inequitably place African American students into lower-level courses is identified and discussed.

Chapter Three

Chapter three provides empirical evidence that the problems associated with ability grouping identified in chapter two exist at the high school used for this study. The needs assessment was conducted at an ethnically diverse suburban public high school located in the Mid-Atlantic United States. The purpose of this assessment was to (1) determine the extent to which African American students at the high school are disproportionately placed into lower-level science courses; (2) identify how science teachers make course recommendation decisions at the school; and (3) identify the effect those decisions have on African American and Caucasian student enrollment in science courses. Results from the needs assessment revealed: (1) African American students are disproportionately represented in basic science courses at the high school; (2) African American students are more likely to be placed into basic science courses than Caucasian students despite similar standardized test scores; (3) teacher recommendations almost exclusively decide student course placements; (4) teachers use subjective, non-meritocratic (data that is not specifically aligned to students' ability and achievement) criteria when making course recommendations for students; and (5) teachers hold opposing beliefs about the benefits and weaknesses of ability grouping. The findings from the needs assessment provided the context needed to explore what frameworks and literature support the identification and development of an intervention.

Chapter Four

Chapter four explains how researchers and school practitioners have begun to address the issues of educational inequalities created by ability grouping by identifying optimal school structures, practices, and processes that will provide all students with equitable opportunities for learning and access to post-secondary degrees in STEM. This chapter presents a review of literature on how to create more equitable practices to ensure all students, regardless of their race socioeconomic background or their academic ability, have access to high quality teachers, instruction, and resources. Three interventions emerged from the literature: (1) fix ability grouping practices to ensure it works as intended; (2) provide students choice for course selection; or (3) eliminate ability grouping by creating heterogeneous classes. Each of these interventions is reviewed and when available, research and viewpoints of opposing sides are presented. After reviewing the interventions, this chapter explores possible institutional barriers and stakeholder resistance associated with changing current grouping practices.

Chapter Five

Chapter five provides the intervention procedure and program evaluation methodology. The intervention employed a mixed methods study that addresses the inequities created by ability grouping. An embedded design was used in which both qualitative and quantitative data were embedded within a major design intervention trial. The quantitative data was used to test the theory that predicts that honors-level mixed ability chemistry classes will positively influence student achievement, interest in science, self-efficacy, and engagement for African American and all other students at the high school. The qualitative data was embedded in this larger design intervention trial for the purpose of measuring teacher and student perceptions and value of their participation in mixed ability classes. The intervention included: (1) creating two mixed ability honors chemistry classes (n=64 students) that employed inquiry-based, student-centered, and differentiated instruction; (2) addressing teachers' beliefs about African American ability, motivation, and intelligence through professional development; (3) supporting initially low achieving students who demonstrate gaps in essential content and skills by providing teachers with student instructional aides; and (4) developing student self-efficacy through teacher professional development on topics including race, equity, cultural proficiency, student goal setting, praise for effort, high expectations, student self-reflection, and growth mindset.

The intervention's short-term outcomes included increasing student achievement in chemistry by ensuring that all students, regardless of their race, ethnicity, or socioeconomic background, have access and opportunity to high-quality instruction, curriculum, and resources. In addition, high-level heterogeneous classes and teacher professional development were used to increase student interest in science, self-efficacy, and engagement compared to students in traditional homogeneous classes. Long-term outcomes included increasing student enrollment and success in post-secondary STEM programs.

Chapter Six

Chapter six concludes with the findings and discussion of the intervention. Results from the study reveal that regardless of course recommendation, initial achievement level, and race, students in high-level heterogeneous science classes outperform their peers in traditionally grouped course levels. Students in these heterogeneous classes now have access to post-secondary STEM degree and career pathways. Findings also show it is important for educators who are detracking their schools to provide professional development to teachers in the areas of differentiated instruction, student self-efficacy, and mindset. Further, it is important to provide teachers in heterogeneous classes with student instructional aides who can help support students with different instructional needs including pacing, scaffolding, and modes of content delivery. Finally, as school and district leaders consider how to detrack their schools they should plan to address possible political and social resistance from staff, parents, and

students. This study provides evidence that heterogeneous science classes produce positive outcomes for all students in science and should be used by educators to leverage stakeholder support and drive organizational change.

Chapter 1: Introduction

More than three million job openings in science, technology, engineering, and mathematics (STEM) will be created by 2022 (Vilario, 2014). These jobs will likely remain vacant, as college graduation rates from the National Science Foundation (NSF) in 2010 show that students earning STEM-related degrees have been at, or below, previous levels (Maltese & Tai, 2011). As concerns about the global economic crisis continues and in order to maintain economic competitiveness, the United States will need more students to pursue STEM degrees to sustain leadership in scientific research and development (Maltese & Tai, 2011).

In attempts to bolster the STEM workforce, policy initiatives have focused an effort on increasing the rigor of mathematics and science preparation in U.S. public schools (Maltese & Tai, 2011). In its 1983 report to the nation, *Educating Americans for the Twenty-First Century*, the NSF set an ambitious goal for high school STEM education to provide “high standards of excellence for all students - wherever they live, whatever their race, gender, or economic status, whatever their immigration status or whatever language is spoken at home by their parents, and whatever their career goals” (Oakes, Ormseth, Bell, & Camp, 1990, p. 5). The NSF was concerned that students, especially minority and low socioeconomic students, were not receiving the same opportunities to learn as other children and was creating significant achievement gaps. In 2009, the NSF identified that little progress was made in supporting minority achievement in STEM since the 1983 report (National Science Foundation, 2009). The new report identified that African American post-secondary degrees and employment in scientific fields remained substantially below their distribution in the population as compared to Caucasians and Asians. Most recently, the U.S. Department of Education (2013) has directed policy makers and education leaders to fully address equality of education and employment opportunities if the U.S. is to remain competitive in the global economy. The Department of Education (2013) describes this focus on equity as a “moral and economic imperative” and advises state departments of education and local districts to ensure all students receive equal access to challenging, high-level courses they need to be successful in the workforce and in post-secondary institutions.

While STEM education is understood to be essential to global economic competitiveness, establishing a scientific literate society has additional benefits. DeBoer (2000) defines scientific literacy as “…what the public should know about science in order to live more effectively with respect to the natural world” (p.594). The Next Generation Science Standards (NGST, 2015) describe how solutions to problems faced by citizens such as pandemics and energy shortages require a substantial understanding of science and technology. In addition, Americans are being forced to increasingly make decisions about health care, technology, energy consumption, and retirement planning where literacy in STEM is imperative (NGST, 2000). These societal demands place African Americans and other minorities at a distinct disadvantage, as they receive fewer opportunities for STEM education as Caucasians and Asians (May & Chubin, 2003).

In an attempt to address issues of educational equality, researchers have examined secondary schools’ organizational practices, structures, and processes and how these elements affect student learning and preparation for college and career. One secondary school process that researchers identify as having significant effects on students’ ability to pursue post-secondary STEM programs is the sorting of students into different course levels, also known as “ability grouping” (Hallinan, 1988; Lucas, 1999; Mayer, 2008; Oakes et al., 1990; Oakes & Guiton, 1995; Oakes, 2005). Ability grouping is the practice of dividing academic subjects into different levels for students with different levels of abilities. In *Keeping Track*, Oakes (2005) identifies three assumptions educators make about ability grouping: (1) it promotes student achievement by better addressing the academic needs of students when they learn in groups with similar levels of prior achievement and capabilities; (2) students with lower-levels of achievement or capabilities will suffer emotional as well as educational damage from daily classroom contact and competition with their higher achieving peers; and (3) most teachers and administrators believe that tracking and ability grouping greatly eases the teaching task and is the best way to manage student differences.

Researchers have discovered that ability grouping creates significant inequities in educational outcomes for students, especially for minority students. African American students are grossly underrepresented in higher-level mathematics and science courses and overrepresented in low-level courses (May & Chubin, 2003). Although underrepresented minorities represent 25 percent of the Nation’s school-aged population, they are only 5-10 percent of AP test-takers in STEM courses (May & Chubin, 2003). Additionally, African American students are more likely to take remedial mathematics courses and score substantially lower on mathematics and science achievement exams (Tyson, Lee, Borman, & Hanson, 2007). African American students have less access to higher-level courses even when they are in schools that offer such courses (May & Chubin, 2003). Because of their inadequate preparation African Americans and other minority students are often precluded from pursuing a career in any STEM field, especially engineering (May & Chubin, 2003).

Statement of the Problem

African American secondary school students are disproportionately underrepresented in higher-level STEM courses (Museus, Palmer, Davis, & Maramba, 2011; Tyson, et al., 2007). The underrepresentation of African American students in higher-level courses preclude them from taking advanced STEM courses required for enrollment into post-secondary STEM degree programs (Maltese & Tai, 2011; Museus et al., 2011; Tyson et al., 2007). A significant factor associated with this problem is the organization of secondary curriculum and instruction that disproportionately tracks or groups African American students in lower-level courses (Hallinan, 1988; Lucas, 1999; Oakes, 2005; Oakes & Guiton, 1995). African American students are often placed into lower-level ability groups or tracks where they receive an inequitable opportunity to learn compared to their peers in higher-level courses (Hallinan, 1988; Lucas, 1999; Mayer, 2008; Oakes et al., 1990; Oakes, 2005; Oakes & Guiton, 1995).

Statement of Purpose

The purpose of this study was to investigate the possible negative effects of ability grouping by creating heterogeneous secondary school science classes with the intent to increase overall student achievement and subsequent access to the STEM pipeline. The intervention used existing school resources to redefine structures, processes, and practices that can exclude low achieving students and students of color from high-level STEM courses. The intervention's short-term outcomes included increasing student achievement in STEM courses by ensuring that all students, regardless of their race, ethnicity, or socioeconomic background, have access and opportunity to high-quality instruction, curriculum, and resources. It was hypothesized that the high-level heterogeneous classes and delivery of teacher professional development would increase student interest in science, self-efficacy, and engagement compared to students in traditional homogeneous classes.

Long-term outcomes include increasing student enrollment and success in post-secondary STEM programs. Students who are successful in secondary high-level science courses and have an interest in STEM are much more likely to pursue post-secondary degrees and careers in STEM (Maltese & Tai, 2011; May & Chubin, 2003; Moore, 2006). As such, if students are successful in heterogeneous honors classes, then they will have the opportunity to take additional high-level courses in high school. Enrollment in these higher-level courses will provide students, especially minority students, with access into the STEM pipeline.

Chapter 2: Review of Literature

The purpose of this literature review is to (1) present a theoretical framework for this study; (2) examine the current literature on how secondary schools sort students into different curricular tracks; (3) identify the effects of those practices on students' preparation to pursue STEM in post-secondary institutions; and (4) explain how sorting students into different ability levels has persisted despite a lack of empirical support. The research presented reflects several different perspectives and represents examples of both qualitative and quantitative methodologies.

Theoretical Framework

The negative effect of ability grouping and tracking on minority and lower-socioeconomic student achievement has been clearly identified in research for more than thirty years; however, the practice of sorting students into curricular tracks continues in American public schools (Hallinan, 1988; Oakes & Guiton, 1995; Oakes, 2005). The entrenchment of this organizational practice can be examined through institutional theory whereby organizations are viewed as social constructs (Burch, 2007; Meyer & Rowan, 2006). By adhering to socially accepted norms, values, and belief structures, organizations carry and perpetuate these ideals through their cultures, social structures, routines, and practices (Burch, 2007; Mayer, 2008; Ogawa, 1992; Powell, 1991). To understand the institutionalism of student sorting into curricular tracks and the processes associated with course placements as social constructs, the relationship between organizations, institutions, and social order are examined in this section.

Formal organizations exist within highly institutionalized contexts that define organizational elements such as professions, policies, products, services, and programs

(Meyer & Rowan, 1977). As such, organizations must adopt these elements in order to look like other organizations and to legitimize their survival within the institution (Burch, 2007; Meyer & Rowan, 2006; Zucker, 1987). Often, this pursuit for legitimacy is made at the expense of maximizing the organization's technical efficiency (Meyer & Rowan, 2006; Riehl, Pallas, & Natriello, 1999; Zucker, 1987). For example, technical procedures are institutionalized for secondary schools that define certain functions such as instruction in history, mathematics, English, and science. In addition, schools that adhere to institutional norms such as teacher tenure, grading practices, and course levels protect them from social and political pressure by establishing them as legitimate and responsible. These elements of organizational structures, practices, and policies are deeply reinforced by the social realities of schools that are reinforced by public opinion (Meyer & Rowan, 1977; Riehl, Pallas, & Natriello, 1999). Organizations are therefore driven to follow powerful institutional rules that do not fully address efficiency and work outcomes.

Public secondary schools are formal organizations that exist within a highly structured institution that adheres to socially accepted norms, values, and belief structures (Meyer, 2006). The formal structure of schools has evolved less from technical efficiency than from the need to maintain their political and social legitimacy (Meyer, 2006). In this view, education is largely controlled by government and societal forces and is seen to include organizations that "passively conform to broader (and already institutionalized) forces, securing success through processes of institutional conformity as opposed to technical efficiency" (Meyer & Rowan, 2006, p.34). As such, schools are not easily shaken by arguments about "suboptimality" or "inefficiency" because their first and foremost mission is to represent and enact societal beliefs and values (Meyer, 2006, p. 218). For example, ability grouping is an organizational practice continued by schools and societal beliefs despite a lack of empirical evidence supporting its efficiency (Lucas, 1999; Oakes, 2005; Riehl, Pallas, & Natriello, 1999; Welner & Burris, 2006). The inability of American schools to fully address the inefficiency of ability grouping has sustained an inequitable opportunity to learn for poor and minority students (Lucas, 1999; Oakes, 2005). As such, the institutionalized practices of ability grouping limit the opportunity for African American and other minority students from pursuing post-secondary degrees and careers in STEM.

Review of Ability Grouping and Tracking Literature

Three conceptual constructs emerge from existing literature identifying how secondary schools group students into course levels and how this grouping affects students' entrance and persistence in the STEM pipeline. First, students' entrance into the STEM pipeline is examined to further define the problem with ability grouping as it relates to STEM. Second, quantitative and qualitative data describing African American students' decreased opportunity to learn in lower-level courses will be reviewed and analyzed. Third, the organizational structures, processes, and practices that inequitably place African American students into lower-level courses will be identified and discussed.

Entrance into the STEM Pipeline

High-level secondary coursework in science and mathematics is important for student learning and leads to significant academic outcomes including post-secondary school enrollment and degree attainment (Tyson et al., 2007). Both the number and rigor of mathematics and science courses enrolled in during high school are positively associated with students continuing in the STEM pathway (Maple and Stage, 1991). Using data from the National Education Longitudinal Study, which sampled more than 12,000 students in eighth grade and tracked them for 12 years, Adelman (2006) found that students who take challenging high school courses are much more likely to complete a baccalaureate degree than any other precollege factor such as parental income or level of education. In addition, students who take more challenging course sequences greatly increase their chances of enrolling into postsecondary institutions (Schneider, Kirst, & Hess, 2003; Tyson et al., 2007). Attewell and Domina (2008) compared survey results from a representative sample (n=7,931) of the nation's eighth grade students in 1988 to the same students' post-secondary transcripts in 2000. They found that students who enrolled in several demanding courses are more likely to attend a four-year college, attend a selective university, and graduate from college than students enrolled in less rigorous courses (Attewell & Domina, 2008).

Secondary course work is also related with how well students perform in college-level courses. Using a nationally representative sample (n=7,518) of college freshman, Bonous-Hammarth (2000) found African-American undergraduate students were less likely to be retained in college STEM majors compared to their Caucasian peers because they were inadequately prepared in K-12 to succeed in these subjects. Precollege success as defined by high GPA and analytical achievement (operationalized by high SAT math scores) was positively associated with post-secondary STEM enrollment and retention (Bonous-Hammarth, 2000). Since post-secondary STEM courses typically require mathematical and analytical skill, students are required to have mastered mathematics and science perquisites in high school (Bonous-Hammarth, 2000). In a qualitative study of 42 African American male college students, Moore (2006) found that high aptitudes for math and science are a primary factor influencing students' decision in high school to pursue post-secondary degrees in STEM. As such, students who do not engage in and who are not successful in challenging secondary STEM curriculum are less likely to pursue and find success in post-secondary STEM programs.

It can be concluded from these studies that African American students placed in lower-level courses decrease the likelihood of them enrolling and finding success in post-secondary STEM programs. It can also be concluded that the organizational process of sorting students into levels disproportionately places African American students into lower-level groups. As a result, this sorting contributes to the underrepresentation of African Americans in college STEM programs and STEM careers. These studies raise important questions regarding the kinds of institutional practices, structures, and processes that lead to African American student course placements. These elements are examined later in this study after the presentation of additional course placement effects on secondary students' opportunity to learn.

Opportunity to Learn

Organizational structures and processes in most secondary schools in the United States continue to differentiate their curriculum into academic course levels also referred to as ability grouping (Hallinan, 1988). Proponents of ability grouping strongly believe that students learn better when they are placed with students of similar ability and that they are easier to teach (Moore, 2006; Oakes, 2005). The results of ability grouping, however, provide students with different subject matter and instruction, depending on the ability group to which they are assigned (Hallinan, 1988; Lucas 1999). African American and other minority students are often disproportionately placed into lower-level tracks within schools that have multiple course levels (May & Chubin, 2003). This racial segregation into different tracks has received considerable attention by researchers in order to measure the quality of education students receive in various tracks (Oakes, 2005). Results from over thirty years of research on tracking show that students placed in lower-level tracks do not receive equitable opportunities to learn, negatively affect student achievement, and contributes to the academic achievement gap between African American and White students (Gamoran, 1987; Hallinan, 1988; Mayer, 2008; Oakes et al., 1990; Oakes, 1995; Oakes, 2005).

In a *Study of Schooling*, John Goodlad (1984) published a comprehensive set of data from 38 schools that included 13 elementary schools, 12 junior and 12 senior high schools, and one school that spanned grades 7 to 12. Goodlad’s data collection included over 10,000 parent surveys and close to 25,000 student surveys (Goodlad, Sirotnik, & Overman, 1979). Data was also collected from over 900 classroom observations and over 800 teacher interviews (Goodlad, Sirotnik, & Overman, 1979). The purpose of the study was to determine what was actually happening in schools including teaching practices, subject matter content, instructional materials, physical environment, activities, human and material resources, evaluation, time, organization, communications, decision making, leadership goals, issues and problems, implicit curricula, and controls, or restraints (Goodlad, Sirotnik, & Overman, 1979). Tracking became, from this study, a matter of considerable interest and concern for researchers and educators. Despite the differences among the 38 schools, they all sorted students based on perceived ability and provided their students with surprisingly similar experiences (Goodlad, 1983).

Oakes (2005) studied 25 of Goodland's original 38 schools to further identify the quality of learning students receive at different track levels. Within the 25 schools, she interviewed students and teachers in 297 math and English classes: 75 high-track classes, 85 average-track classes, 64 low-track classes, and 75 heterogeneous classes. Oakes (2005) found that teachers of high tracked classes were more likely to engage students in critical thinking, independent work, active participation, self-direction, and creativity than were teachers of lower tracked classes. At the same time, Oakes (2005) found "teachers of lower-track classes were more likely than others to emphasize student conformity: students getting along with one another, working quietly, improving study habits, being punctual, and conforming to classroom rules and expectations" (Oakes, 2005, p. 85). Oakes (2005) also found that instructional time and average expected homework time was significantly greater for higher-level courses compared to lower-level courses. In addition, results from student interviews showed that high-tracked students "saw their teachers as more concerned about them and less punitive toward them than did students in low tracks" (Oakes, 2005. P.85). In summary, Oakes (2005) concluded that students, in fact, do not receive equitable opportunities to learn when placed in different curricular tracks and that this inequity is a result of organizational structures and processes that support tracking.

Other studies have researched the effect of ability grouping on non-cognitive factors such as student self-efficacy. Bandura (1994) defines self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 71). Students' sense of self-efficacy is an important factor associated with student achievement in schools and students with greater levels of self-efficacy demonstrate greater levels of achievement (Zimmerman, Bandura, and Martinez-Pons, 1992). Further, students placed in higher-level secondary courses are more likely to have a greater degree of self-efficacy than students in lower-level classes (George, 1993; Hall, 2014; Rui, 2006; Yonezawa & Jones, 2006). In a study of 2,279 mathematics students in grades 6-8 across four middle schools, Hall (2014) found that high tracked students believed in themselves to be more capable than their peers in low tracked courses. Students with the lowest self-efficacy were enrolled in the lowest level mathematics courses. In a qualitative study of 12 high schools across two school districts, Yonezawa and Jones (2006) identified students' perspective of tracking by holding 75 focus groups with over 500 students. Findings from this study revealed that students in higher tracks had a greater belief in their ability to be successful in school than their peers in lower tracks.

These studies provide evidence that African American students in lower-level courses do not receive the same learning opportunities as their peers in higher-level courses. Differences in learning opportunities produce inequitable academic and non-cognitive outcomes for these students. Again, this literature raises important questions as to how and why students are placed into lower-level courses. More specifically, the results raise serious concerns about the equality of educational opportunities for African American and other minority students. The next section will provide possible answers to these questions by identifying specific institutional structures, processes, and practices that schools use to sort students into course levels.

Course placement processes

The act of sorting students into different curricular tracks is accomplished by a variety of mechanisms that have enormous potential for discrimination (Oakes, 2005). These mechanisms include several school and individual student factors, such as counselor and teacher recommendations, school size, standardized test scores, and/or parental student requests (Bernhardt, 2014; Campbell, 2012; Gamoran, 1992; Yonezawa & Jones, 2006). Researchers have concluded that the process of curricular differentiation is an implicit rather than explicit process that provides considerable variation in how students are placed into courses (Bernhardt, 2014: Lucas, 1999; Mayer, 2008; Oakes, 2005). Because the process is not explicit, sorting mechanisms include subjective assessments of student ability, parental influence, irrelevant or narrow evaluations, counseling, and advice (Oakes, 2005). As a result, parents and students may not be aware that students are receiving different curricula, and parents have little or no input in the process of deciding which curriculum best fits their children (Lucas, 1999; Mayer, 2008). In addition, the subjectivity of the processes inequitably places a disproportionate number of African American students in lower-level courses (Oakes, 1995; Oakes, 2005).

Oakes and Guiton (1995) used both quantitative and qualitative data at three urban high schools with varying demographics (n=2,468 students) to study how students are placed into course levels. They found school staff views their students' abilities, motivation, and aspirations as fixed and that high school courses could not increase a student's intellectual capacities or raise their expectations. For this reason, teachers expressed reluctance to move students out of remedial classes or tracks to higher levels. As a result, Oakes and Guiton (1995) concluded that schools see their job as offering programs that *accommodate* rather than *alter* their students' abilities and motivation. In this view, teachers design and deliver instruction at or below their perceived level of student ability rather than offering challenging learning opportunities that increase intellectual capacity. This view also tends to place students in course levels without an opportunity to advance to a higher-level during subsequent years and has been shown to affect racial and ethnic minorities' course placements (Oakes & Guiton, 1995; Oakes, 2005). Studies have found educators' perceptions of students' suitability for classes at various course levels to be influenced by race, ethnicity, and social class (Aschbacher, Li, & Roth, 2010; Campbell, 2012; Francis, 2012; Oakes & Guiton, 1995; Oakes, 2005). At each of the three schools studied by Oakes and Guiton (1995), African American students had become identified in most educators' minds with belonging in lower-level courses. This mindset resulted in the placement of African American students into lower-level courses even when their standardized test scores and other objective measures were identical or higher than their Caucasian and Asian peers.

A considerable amount of evidence identifies that educators' perceptions of student ability are influenced by factors associated with students' race and ethnicity (Mayer, 2008). This body of literature on teacher perceptions identifies that Caucasian teachers hold more negative perceptions of African American students than of Caucasian students (Ferguson, 2003; Francis, 2012; Tenenbaum & Ruck, 2007; Oakes, 2005). For example, Francis (2012) used data from the Early Childhood Longitudinal Study (n=3,017) to examine the extent to which teacher perceptions of attentiveness and disruptiveness is influenced by their students' racial background. Results identify that teachers perceive African American black female students as less attentive and more disruptive than their Caucasian peers. Teachers who perceived the African American students to be less attentive were much more likely to recommend them to lower-level courses. In another study, Campbell (2012) used survey data from the 2002 Education Longitudinal Study of 15,362 sophomores in public and private high schools to examine factors that influence higher-level course placements for African American students. Campbell found that teachers' expectations about African American girls are a significant contributor to course placement decisions even after controlling for achievement. In addition, teachers who expected African American girls to complete high school but not attend college were less likely to recommend them for honors or advanced courses (Campbell, 2012).

Aschbacher, Li, and Roth (2010) used interview and survey data from an ethnically and economically diverse student sample (n=1,247) across 33 diverse high schools to explore family and school factors that may affect the trajectory of high school students' science identity, participation, and aspirations. This study found that high-achieving students were predominantly Caucasian and Asian who received a breadth of support from parents, science-supportive teachers, counselors, and administrators. These students were offered and enrolled into more advanced courses where they invested considerable time and effort to maintain their identities as good science students. These results support earlier research confirming that teachers favor Caucasian students for higher-level courses compared to African American students by holding more positive expectations for Caucasians (Ferguson, 2003; Tenenbaum & Ruck, 2003).

Riehl, Pallas, and Nariello (1999) studied the course placement process at five urban high schools with varying demographics and district contexts to determine if educational organizations are likely to rely more on institutional rules than technical efficiency. Specifically, they sought to observe the organizational routine of course scheduling and how it may not be closely coordinated within the context of each school but rather retain the appearance of conformity to institutional norms. The researchers found that the course scheduling process is more successful as a socially constructed ritual than as a technically rational process. Although the schools faced a barrage of complexities and uncertainties throughout the course placement process resulting in ineffective scheduling, the schools persisted in employing a traditional process that enabled them to enact important institutionalized beliefs about students and schooling. For example, each of the schools in the study experimented with different course assignment strategies, and changed those strategies each year if they were not working. The researchers concluded that the decisions occurring during a student's course scheduling process happened "ad infinitum" so that it was impossible to predict how a student might, for example, be assigned to an honors course or a basic science course: "honors is not honors - we'll put anybody who is doing fairly well in there, get rid of the behavior problems" (p. 141).

Bernhardt (2014) identified how three social studies teachers make decisions about course placement recommendations in one public high school. Bernhardt (2014) found that teachers have a high level of autonomy when making course recommendations. The teachers used recommendation criteria that they believed were best suited to determine student success in advanced-level courses. They also received ill-defined expectations and poor communication from administration regarding course recommendation processes. As a result, each teacher used different criteria to recommend students for the same classes. Teachers also felt they did not have a significant impact on their students' academic trajectories; they assumed students, parents, and counselors had a much greater impact.

The literature presented in this section describes educators' beliefs and behaviors that support the institutionalized practice of ability grouping. The research literature on course recommendation processes identifies that African American students are inequitably sorted into lower-level courses providing them with an inequitable opportunity to learn. Institutional theory explains that the persistence of ability grouping practices, despite the evidence of its inefficiency, results from socially accepted norms, values, and belief structures that support the practice.

Discussions and Conclusions

Schools are formal organizations that exist within a highly structured institution that adheres to socially accepted norms, values, and belief structures. It is common practice for schools to differentiate curriculum and to sort students into course levels under the assumption that students learn best in homogenous groups. Current sorting practices disproportionately place African American students in lower-level courses compared to their Caucasian peers. The subjectivity of course placement processes allows for educators' biases and perceptions about students' abilities to influence the course recommendation process. Once placed in lower-level courses, it is unlikely that students will move to higher-levels. In these lower-level courses, students receive an inequitable opportunity to learn that precludes them from enrolling into post-secondary STEM education and from pursuing a career in STEM.

As with all research, there are limitations to the studies presented in this literature review. The literature predominantly generalizes the problems associated with ability grouping through broad empirical and theoretical research. This non-contextual approach creates a limitation that needs to be addressed. For example, the variability in demographics, socioeconomics, organizational structures and processes, school leadership, politics, interest groups, and accountability between schools requires school-based evidence to determine the scope of the problem within individual schools. This limitation is supported by schools that made an effort to dismantle or improve the process of tracking and ability grouping, but failed to first identify the state of the problem within the context of their organization (Yonezawa, Wells, & Serna, 2002; Yonezawa & Jones, 2006). As a result, many of these schools' initiatives were unsuccessful.

To address these limitations, evidence from previous research was used to create a school-based needs assessment to support the development of a school-based solution to the problems associated with ability grouping. The goal of the needs assessment was to clarify and operationally define the state of the problem within the context of a high school and to identify areas to be addressed by an intervention. Institutional theory identifies how difficult it can be to change school practices, structures, and processes, as the institution legitimizes their current state. One way to challenge this legitimacy is to present contextual data that clearly identifies the inefficiency and discriminatory practices of the organization. The next chapter describes the methodology and results of a needs assessment conducted at the high school researched in this study.

Chapter 3: Needs Assessment

A needs assessment was conducted at an ethnically diverse suburban public high school located in the Mid-Atlantic United States with an enrollment of 2,147 students. School demographics include 28 percent African American, 28 percent Caucasian, 18 percent Asian, 20 percent Hispanic, and 6 percent Multiple Race students. Thirty percent of students receive free and reduced meals (FARMS).

The organization of science curriculum and instruction at the high school includes the sorting of students into on-level (basic), honors, or Advanced Placement (AP) courses. The school's sorting process is built on the assumption that student ability is predictable and that teachers can make objective decisions about course placements. As a result, it may allow for teachers' biases and subjective perceptions about students' ability to influence placement decisions. The course placement process begins with teachers making course recommendations for their students. Each academic department has developed its own criteria for sorting students that typically uses current course grades; however, it is the teachers' responsibility to decide on the appropriate recommendation based on their professional judgment. If a student does not agree with the teacher's recommendation then he/she is required to submit a written request to change his/her course placement and obtain signatures from a counselor, parent, teacher, and administrator.

Goals and Objectives

The purpose of this assessment was to (1) determine the extent to which African American students at the high school are disproportionately placed into lower-level science courses; (2) identify how science teachers make course recommendation decisions at the school; and (3) identify the effect those decisions have on African American and Caucasian student enrollment in science courses.

This assessment examined the following research question to develop a deeper understanding of the problem within the school: In what ways do the organizational structures, processes, and practices of course recommendations and placements at the school affect African American representation in high-level science classes? To fully address this research question, the following questions were examined in this assessment:

- What is the process for placing students into basic (on-level) and advanced (honors and Advanced Placement) science courses at the school?
- What is the representation of African American students in basic and advanced science courses compared to their Caucasian peers at the school?
- What criteria do teachers use to make course recommendations at the school?
- What are the school's science teachers' biases and perceptions of African American students' ability compared to their Caucasian peers, and how do these biases and perceptions affect the course placement process?
- What are science teachers' beliefs about ability grouping and heterogeneous classes?

Methodology

Description of Setting and Study Respondents

This assessment was conducted at an ethnically diverse suburban public high school located in the Mid-Atlantic United States with an enrollment of 2,147 in grades 9-12. School demographics include 28 percent African American, 28 percent Caucasian, 18 percent Asian, 20 percent Hispanic, and 6 percent Multiple Race students. Thirty percent of students receive free and reduced meals (FARMS). Science course enrollment data was collected in grades 9-11 for both African American and Caucasian students. Grade 12 data was not examined because students are not required to take a science course in grade 12. A total of 445 African American and 486 Caucasian students' science course enrollments were analyzed. A standard score of standardized achievement measures was also created for 121 African American and 155 Caucasian students in grade 10.

Once teachers make course recommendations, students must complete a course change request form that includes their parent, counselor, administrator, and current teacher's signature in order to request a change in course level (i.e., a change from a basic science to advanced science course). Course change forms were analyzed for all African American (n=592) and Caucasian (n=648) students in grades 8-11 who will be in grades 9-12 during the next school year.

The school's science teachers (n=19) were surveyed to determine the criteria they use to make course placement decisions and to identify their beliefs about ability grouping and heterogeneous science classes (see Appendix A).

Variables Used in the Analysis.

Table 1 identifies the key variables and indicators for this assessment.

Table 1 *Needs Assessment Key Variables and Indicators.*

Variables	Indicators
Enrollment of African American students compared to their Caucasian peers in basic (on-level) and advanced (honors and AP) level science courses.	Student enrollment data in basic (on-level) and advanced (honors and AP) level science courses.
Achievement index of African American students and their placement into course levels compared to their Caucasian peers.	A standard score was created using student assessment measures including Maryland State Assessment in Mathematics and Reading and PSAT score data. Standard scores were divided into ranges and science course enrollment was tallied for each range.
Frequency and percentage of course change requests by students and parents after teacher course recommendations.	Number of course change requests made by both African American and Caucasian students.
Teachers' decision-making process for course recommendations and their biases and perceptions about ability grouping and heterogeneous classes.	Survey to science teachers to determine their decision making process for course recommendations and their beliefs about ability grouping and heterogeneous science classes.

Data Collection Methods.

The percentage of African American and Caucasian students enrolled in basic and advanced science courses in grades 9-11 was calculated using publically available enrollment data. Z-tests of two proportions were used to analyze the two populations in grades 9-11 under the null hypothesis that there is no difference between African American and Caucasian student enrollment in basic and advanced science courses at a confidence level of 99 percent. Chi-square analysis was used to identify associations between ethnicity (African American and Caucasian students) and science course placement (basic and advanced) at a confidence level of 99 percent. The null hypothesis for the Chi-square analysis asserts the independence of ethnicity and science course placement.

A standard score was created for all African American and Caucasian students in grade 10 using Maryland State Assessment (MSA) scores in both Math and Reading and PSAT total combined scores. These exams were selected for this study because the school and district frequently use these exams to predict students' academic ability and the school made the standard scores publically available. Students who had not taken one or more of these tests were not considered in this analysis. Assessment scores for each student were adjusted so that all three assessments are equally weighted in the standard score. For example, the highest possible MSA assessment score is 650. MSA scores were adjusted by a factor of .0308 producing a maximum standard score of 20 units. The highest possible combined PSAT score is 240. PSAT scores were adjusted by a factor of .0833 producing a maximum standard score of 20 units. The sum of all three adjusted assessment scores (MSA Math, MSA Reading, and PSAT) produced a final achievement standard score. The range of possible standard scores is 0-60 with each assessment contributing to one-third or 20 units of the final standard score. Standard scores were divided into ranges and the proportion of basic science placements for African American and Caucasian students were analyzed using Z-tests of two proportions under the null hypothesis that there is no difference between groups.

Publically available data on student course request changes were also examined in this needs assessment. The number and percentage of course change requests to move from a teacher recommended basic science course to an advanced science course was calculated using course change forms submitted to counselors by students. Since teacher recommendations could not be disaggregated by grade level due to scheduling software limitations, course recommendations and course change requests were calculated for students in grades 8-11 (grades 9-12 for the next school year). A Z-test of two proportions was used to analyze the two populations in grades 8-11 under the null hypothesis that there is no difference between African American and Caucasian student course change requests at a confidence level of 99 percent.

Survey responses from science teachers were collected electronically using a Google Form (Appendix A). Submissions were anonymous and results were analyzed using descriptive statistics. Survey participants provided informed consent to participate in the survey (Appendix B).

Needs Assessment Findings

The racial makeup of the school in grades 9-11 (Table 2) includes 27 percent African American (n=445) and 30 percent Caucasian students (n=485). The percentage of all student enrollments into basic science courses is 47 percent African American compared to 18 percent Caucasian. The percentage of African American students placed into basic science of all students in grades 9-11 is 15 percent compared to 6 percent for Caucasian students.

The percentage of African American students enrolled in basic science courses is significantly greater ($p<.01$) than their Caucasian peers in grades 9-11 (Table 2). In ninth grade, 51 percent of African American students are placed into basic science courses compared to 14 percent of Caucasian students. Similar percentage differences are found in grades 10 and 11 (Table 3). This disparity is also highlighted in course enrollment numbers (Table 4). At each grade level the number of African American students is greater than Caucasian students. In ninth grade, 89 African American students are placed into basic science compared to 23 Caucasian students. Similarly, these differences are found in grades 10 and 11 (Table 4).

A significant association ($p<.01$) between ethnicity and course placement exists at all grade levels (Table 5) suggesting that African American students are associated with placements into basic science courses. Alternatively, Caucasian students are associated with placements into advanced science courses.

There is a significant difference ($p<.05$) between African American and Caucasian student placements into basic science courses for a standard score range of 33-35 (Table 6). Within this range, 66 percent of African American students are placed into basic science courses as compared to 35 percent of Caucasian students. The percentage of African American and Caucasian student placements at all other standard score ranges are similar and show no significant difference. It is worth noting that 36 Caucasian students have a standard score of greater than 42 compared to one African American student (Table 6).

The percentage of African American and Caucasian students recommended for a basic science course who submitted course change requests is 2.7 and 12.1 percent respectively (Table 7). While the numbers of course change requests are small for both groups (8 percent for African American and 15 percent for Caucasian students), they are significantly different ($p<.01$).

Survey results show that teachers use a variety of criteria when making course recommendations (Figure 1). 95% of teachers use course grades and 90% use homework completion when making course recommendations. In addition, 100% of teachers use more subjective criteria such as students' work ethic and 79% use their perception of student attention and focus in class when making recommendations. Survey results also show there are different beliefs about the benefits and drawbacks of academic ability grouping (Table 8). The majority of teachers believe that ability grouping perpetuates inequalities and segregation of students based on race and social class and a majority of teachers believe that academic ability grouping is harmful to lower-achieving students. Teachers are split on their belief that academic ability grouping is beneficial to high-achieving students. A majority of teachers believe that academic ability grouping does not enhance self-concept of either high- or low-achieving students and that it is not a helpful classroom management tool. While the majority of teachers believe that ability grouping is ineffective and creates education inequities, they believe that teaching heterogeneous classes is more difficult and prefer to teach higher-achieving students.

Table 2 *Percent enrollment for African American and Caucasian students in grades 9-11.*

Ethnicity	$\%_{Population}$[1]	$\%_{Basic(1)}$[2]	$\%_{Basic(2)}$[3]
AA	27	47	15
WH	30	18	6

[1] $\%_{population}$=percentage of total school population in grades 9-11
[2] $\%_{Basic(1)}$=percent enrollment in basic science courses of all students in basic science in grades 9-11 (n=587)
[3] $\%_{Basic(2)}$=percent enrollment in basic science courses of entire student population in grades 9-11 (n=1,644)

Table 3 *Enrollment in basic science courses as a percentage of student populations.*

					99% Cl[4]	
Grade	AA%[5]	N_{AA}[6]	WH%[7]	N_{WH}[8]	z[9]	p[10]
9	51	175	14	163	7.17	<.0001
10	66	138	25	159	7.06	<.0001
11	46	132	17	164	5.57	<.0001

Table 4 *Enrollment in basic and advanced science courses for grades 9-11.*

Grade	Ethnicity[11]	N_B[12]	N_A[13]	N_T[14]
9	AA	89	86	175
	WH	23	140	163
10	AA	91	47	138
	WH	40	119	159
11	AA	61	71	132
	WH	27	137	164

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4 Cl=confidence interval
5 AA%= percent of African American students placed into basic science.
6 N_{AA}=total number of African American students taking basic and advanced science courses
7 WH%= percent of Caucasian students placed into basic science
8 N_{WH}= total number of Caucasian students taking basic and advanced science courses
9 z=two-tailed Z-test of 2 proportions
10 p<.01
11 AA=African American; WH=Caucasian
12 N_B=Enrollment in basic science courses
13 N_A=Enrollment in advanced science courses
14 N_T= Total enrollment in science courses

Table 5 *Chi-square analysis predicting the association between African American and Caucasian student placement into basic and advanced level science courses for grades 9-11.*

Grade Level	99% Cl[15] X^2[16]	df[17]	n	p[18]
9	20.88	1	338	<.0001
10	46.78	1	297	<.0001
11	30.98	1	296	<.0001

Table 6 *Standard score ranges of achievement indexes for African American and Caucasian students and science course placements in grade 10.*

Standard Score	n_{AA-B}[20]	n_{AA-T}[21]	%AA[22]	n_{WH-B}[23]	n_{WH-T}[24]	%WH[25]	95% Cl[19] z[26]	p[27]
27-29	9	9	100	2	2	100	-	-
30-32	22	24	92	16	19	84	.76	.44
33-35	23	35	66	8	23	35	**2.3**	**.02**
36-38	5	30	17	6	37	16	.05	.96
39-41	0	18	0	0	37	0	-	-
42-44	0	1	0	0	26	0	-	-
45-47	0	0	0	0	7	0	-	-
48-50	0	0	0	0	3	0	-	-

[15] *Cl=confidence interval*
[16] *X^2=Chi-square analysis*
[17] *df=degrees of freedom*
[18] *p<.01*
[19] Cl=confidence level
[20] n_{AA-B}=number African American students in basic science courses
[21] n_{AA-T}=total number of African American students in science courses (basic and advanced)
[22] %AA=percentage of African American students in basic science for each standard score range
[23] n_{WH-B}= number Caucasian students in basic science courses
[24] n_{WH-T}= total number of Caucasian students in science courses (basic and advanced)
[25] %WH=percentage of Caucasian students in basic science for each standard score range
[26] z=two-tailed z-test of 2 proportions
[27] p<.05

Table 7 *Number and percentage of course change requests to move up to advanced-level science from basic-level science.*

Grade Level	Ethnicity	n_B[29]	n_A[30]	n_T[31]	Requests[32]	%[33]	99% Cl[28] z[34]	p[35]
8-11	AA	293	297	592	8	2.8	3.8	<.0001
	WH	124	524	648	15	12.1		

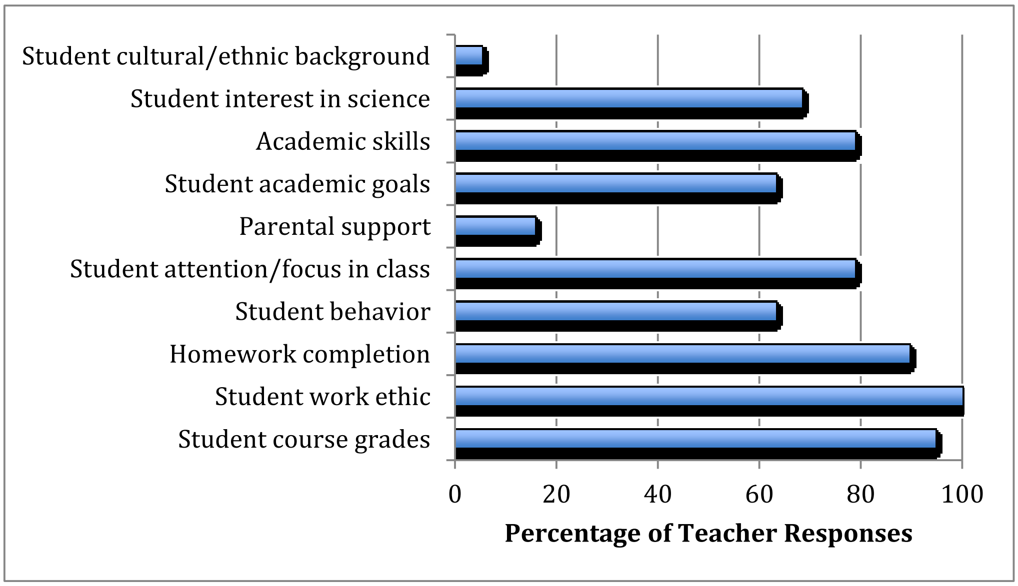

Figure 1 *Percentage of teacher responses to the criteria used during the course recommendation process.*

[28] Cl = confidence level
[29] n_B = number of students recommended by teachers for basic science courses;
[30] n_A = number of students recommended by teachers for advanced science courses
[31] n_T=total number of students recommended by teachers for both basic and advanced science courses
[32] Requests=number of requests by students and parents to move u*p* to an advanced science from a basic recommended science
[33] %=percent of students recommended for basic science who requested to move up to an advanced science
[34] z=two-tailed z-test of 2 proportions
[35] p<.01

Table 8 *Number of responses from teachers on survey questions about their recommendation processes and beliefs about ability grouping.*

Survey Question	Strongly Disagree	Disagree	Agree	Strongly Disagree
Science teachers play an important role in determining the science classes students enroll in.	2	2	11	4
Parents play an important role in determining the science classes students enroll in.	1	6	8	4
Students play an important role in determining the science classes they enroll in.	1	0	14	3
Students are allowed to choose the classes they would like to enroll in.	0	7	9	2
Science teachers communicate with other teachers in their department about issues related to student course placement.	2	0	14	2
Parents are aware that students are enrolled into science classes taught at different academic levels.	3	2	11	2
Students are aware they are enrolled into science classes taught at different academic levels.	1	4	8	5
Once a student is placed in an on-level science class it is difficult to move into a higher-level track.	4	5	7	2
Students in on-level science classes are provided with adequate information to make informed decisions about enrolling in academically advanced classes (AP, honors, and on-level).	2	11	3	2
Parents of students in on-level classes voice their concerns about the impact of ability grouping/tracking.	6	10	3	0
Parents of students in honors and AP classes voice their concerns about the impact of ability grouping/tracking.	5	4	7	2
The school has written policies/guidelines for assigning students to classes.	3	6	8	1
The science department has written policies/guidelines for assigning students to classes.	3	6	7	3
Science teachers use the same criteria when recommending students for classes.	2	4	9	2
Science teachers use similar criteria when recommending students for classes.	2	4	12	1
Criteria used by science teachers to recommend students for classes are determined at the department level.	2	6	7	3
Individual teachers determine criteria used to recommend students for classes.	1	12	6	0
Course placement recommendations should be based on academic criteria such as test scores and grades.	0	5	10	3
Teachers should consider non-academic criteria such as effort, attitude, or future aspirations when making course placement recommendations.	0	3	12	4
Course placement recommendations should be based on a combination of academic and non-academic factors.	0	5	9	4
	6	11	0	1

Criteria used by science teachers to recommend students for classes should be decided by school administration.				
Criteria used by science teachers to recommend students for classes should be decided at the department level.	0	5	10	4
Individual teachers should decide criteria used to recommend students for classes.	0	10	5	2
Slower learners would benefit more if placed in classrooms with students of higher ability.	2	5	7	4
Brighter students learn best when grouped with brighter students.	4	4	7	4
Academic ability grouping/tracking seems to separate students by social class.	2	1	10	5
Academic ability grouping/tracking seems to separate students by race.	4	4	7	3
Academic ability grouping/tracking has negative consequences for the future educational, employment or life chances of some students.	2	5	9	3
There is a better spirit of cooperation among students if they are grouped/tracked with students of similar ability.	1	7	8	2
I can often determine the grouping/track a student is in or will be assigned soon after I meet him/her.	6	7	4	1
Academic grouping/tracking enables teachers to provide top quality educational experiences education to all students.	3	8	7	0
Academic grouping/tracking enhances academic achievement of faster learners.	1	7	7	2
Academic grouping/tracking enhances academic achievement of slower learners.	3	11	3	1
Academic grouping/tracking enhances self-concept of faster learners.	3	8	7	0
Academic grouping/tracking enhances self-concept of slower learners.	3	10	3	2
In general, teachers in my school are supportive of academic ability grouping/tracking.	0	2	15	1
Academic ability grouping/tracking is helpful as a classroom management tool.	4	10	4	0
I prefer to teach higher ability groups.	1	4	12	1
Academic ability/grouping tracking perpetuates inequality in America.	2	5	6	5
A mixed ability class is just as easy to teach as a homogeneous class.	6	7	4	2

Implications

African American students are disproportionately represented in basic science courses in grades 9-11 at the high school (Tables 2 and 3). African American students make up 27 percent of the school population in grades 9-11 yet 47 percent of enrollments in basic science are African American students compared to 18 percent Caucasian students. Significant differences in enrollment proportions ($p<.01$) at all grade levels between African American and Caucasian students further illustrate the disparity in science course placements. These results support previous studies highlighting the overrepresentation of African American students in lower-level high school courses (Hallinan, 1988; Lucas, 1999; Oakes & Guiton, 1995; Oakes, 2005; Tyson et al., 2007).

African American students with slightly below average test scores are more likely to be placed into basic science courses than Caucasian students with the same scores ($p<.05$). Within the standard score range of 33-35, 66 percent of African American students compared to 35 percent of Caucasian students are placed into basic science courses. These findings are consistent with previous research identifying the inequitable placement of African American students in lower-level courses compared to their Caucasian peers when standardized tests and other objective measures are examined (Oakes & Guiton, 1995). These results raise serious concerns about how science teachers make course recommendation decisions for their students.

Just as concerning is the low number of students who appeal teachers' course recommendation decisions. While White students are more likely to submit course change requests than African American students, both groups submit very few requests. Only 2.7% of African American and 12% of White students recommended for basic science requested a change to an advanced level science course. These results suggest that teacher recommendations almost exclusively decide student course placements.

These results question the equity of the course placement process at school. The course placement process at the school is based on the assumption that teachers make objective course recommendations for their students; however, it provides teachers with opportunities to exercise their professional judgment when making course recommendations. Changes to teacher recommendations require parents to submit a written request for a course change and signatures from the student's counselor, teacher, and administrator. Many parents may not fully understand this requirement or they may trust the teachers' judgments to make course placements. Previous studies report that educator' biases and perceptions of student ability results in inequitable course placements for minority students (Aschbacher, Li, & Roth, 2010; Campbell, 2012; Francis, 2012; Oakes & Guiton, 1995; Oakes, 2005). As such, the cause for African American overrepresentation in basic science courses at the school could be a result of teachers' biases and perceptions of student academic ability.

Results from the teacher surveys provide insight into the causes of placement disparities between African American and White students. The data identifies subjective, non-meritocratic (data that is not specifically aligned to students' ability and achievement) factors used by teachers during the course recommendation process and how teachers' biases and perceptions of student ability affect course placement decisions. These results are consistent with previous studies that identify teachers' use of subjective criteria when making course recommendations (Bernhardt, 2014; Oakes, 2005). Further, the use of non-meritocratic data in teacher decision-making processes has been shown to contribute to the inequitable placement of minority students in high-level courses (Oakes, 2005).

Survey results from this study show that teachers have opposing beliefs about the benefits and weaknesses of ability grouping. These findings are consistent with data collected from a sample of 1,500 teachers across 45 schools studied by Hallam & Ireson (2003). In their study, Hallam & Ireson (2003) found teachers have little agreement on the benefits and equity of ability grouping and that attitudes on ability grouping were correlated to the type of school where they taught and the subjects they teach. Interestingly, this study finds that most teachers believe in the negative effects of ability grouping such as segregation by race and increased behavior problems; however, they would much rather teach high-level ability grouped classes. These results are consistent with other studies that find teachers prefer teaching high-level classes because there are less behavior problems and students tend to be more motivated learners in those courses (Welner & Oakes, 2000). The next chapter explores ways in which ability grouping and teachers' beliefs about ability grouping can be addressed so that all students can find success in high-level course work.

Chapter 4: Detracking

Researchers and school practitioners have debated the impact of ability grouping on student achievement for the past thirty-five years. Proponents of ability grouping believe it provides students with developmentally appropriate curriculum and allows teachers to address the needs and abilities of their students (Oakes, 2005). In this view, teachers of high-ability students can provide challenging material at a faster pace while students in lower-ability classes can benefit from a slower pace and targeted attention to their needs. A large body of research, however, has shown ability grouping to separate students by race and socioeconomic status, provide students with inequitable access to challenging curriculum and instruction, and re-segregate diverse schools (Hallinan, 1988; Lucas, 1999; Oakes, 2005; Oakes & Guiton, 1995). As such, critics of ability grouping have advocated for the elimination of ability grouping or fixing course placement practices to reduce inequities.

Secondary school ability grouping has important implications for African American students' entrance into the STEM pipeline. Current grouping practices disproportionately place African American students into lower-level science and mathematics courses precluding them from entrance into post-secondary STEM degree programs (Maltese & Tai, 2011; Museus et al., 2011; Tyson et al., 2007). Therefore, the opportunity for African Americans to pursue careers in STEM is limited to their secondary school course-level placement in science and mathematics. In an attempt to address the issues of educational inequalities created by ability grouping, researchers and school practitioners have begun to identify optimal school structures, practices, and processes that will provide all students with equitable opportunities for learning and access to post-secondary degrees in STEM. Administrators, teachers, students, and parents who hold positive beliefs about ability grouping as an institutional practice, however, typically challenge organizational change. This oppositional resistance creates political and social challenges that reformers must address throughout the change process. To fully understand the resistance tied to changing institutional practices, this review of literature begins by identifying the historical evolution of tracking and ability grouping in the United States. Next, the variety of ways in which practitioners have challenged their school's organizational structures and practices in an attempt to create more equitable learning opportunities for their students is reviewed.

Historical Context of Tracking and Ability Grouping

The roots of tracking in the United States extend back to the late nineteenth century as public high schools developed in response to the influx of immigrant children. Prior to the reform movement, public "common schools" provided universal education to primary children and few students, predominately Caucasian middle and upper class, enrolled into private secondary schools. Between 1880 and 1918 student enrollment in public schools increased from 200,000 to over 1.5 million and by 1920, over 60 percent of school aged children were enrolled in public schools (Oakes, 2005). Immigration resulted in a significant increase in urban school diversity where by 1909 58 percent of children were from foreign-born parentage (Oakes, 2005). School reform quickly became a focus of social and political agendas as the purpose of schooling began to be questioned. While poor and immigrant families desired the economic advantages promised by education, organized labor was concerned about controlling and training future employees. Middle and upper class families were increasingly concerned about the potential dangers associated with unrestrained urban immigrant children and therefore advocated for schools to exert greater social control over the nation's youth (Kelley, 1903). In addition, colleges and universities wanted more pre-college preparation to ensure students were ready for post-secondary education.

In response to these demands, compulsory comprehensive high schools were established that promised to educate all students, but not to educate them in the same way. This promise led to curriculum differentiation – tracking and ability grouping - and distinctive learning outcomes for different groups of students. In *Tracking Inequities*, Lucas (1999) explains the social, economic, and political implications for the new school structure:

This form allowed students to be given distinctly different cognitive preparations as well as distinctly different socialization. Ostensibly, this differentiated curriculum allowed students to be educated in ways relevant to their future social, economic, and occupational roles. Because projected occupations often were based on parental status, by providing training targeted to students' projected occupational positions, the school buttresses the existing social order. Thus, the differentiated curriculum harbored a pro-status-quo bias (Lucas, 1999, p. 3). The newly reformed school structure was supported at the time by current theories of social order and human intelligence. In *Keeping Track*, Jeannie Oakes (2005) describes how the application of Charles Darwin's theory of evolution supported school reform:

> Social and economic power was seen as being held by "great men"- those most "fit" to do so. Their survival in a competitive social environment was proof enough of their evolutional superiority. It followed that ethnic minorities and the

> poor were seen as being responsible for the terrible living conditions, as inherently "less fit" and at a lower evolutionary stage than Anglo-Protestants (Oakes, 2005, p. 21).

These beliefs justified a school structure that provided additional opportunities for the social elite by sorting them into college preparatory tracks. It also supported the belief that schools should assimilate immigrant children into American mainstream culture to preserve the dominant Caucasian Anglo-Saxon culture. This assimilation included sorting poor and immigrant children into vocational tracks where they could learn obedience, discipline, and moral values (Oakes, 2005).

In addition to Social Darwinism, sociologists and psychologists supported theories of fixed intelligence. Ross Finney (1928), an influential twentieth-century sociologist of education, theorized that many people have "…brains of just average quality or less, of whom a very considerable percentage have poor brains indeed" (Finney, 1928, p. 385-386). In this view, teaching advanced curriculum to all students was seen as a waste of resources because not all students have the capacity to learn. Moreover, Finney (1928) asserted that social stability in a democracy required good followers of social order and some believed that educating the less able could result in disobedience. As such, it was believed that making good followers and good leaders required school structures that sorted students into groups for different socialization.

With social, political, and theoretical support, tracking quickly became an institutional process in the late twentieth century that did not receive much attention until the Civil Rights movement in the 1960s. With growing concerns about equity and the development of new theories of intelligence (from fixed to malleable), some school districts began to dismantle formal structures of tracking where students were no longer sorted into different pathways (e.g., vocational or college preparatory), rather into different course levels (e.g., honors, regular, or remedial). This structural change created a new kind of tracking that "…allows continued stratification within subjects, but breaks necessary relation across subjects" (Lucas, 1999, p. 8). The assumption supporting this structure is that it allows students an opportunity to enroll in different course levels across disciplines and to move between course levels throughout their education. What still remains with this structure, however, is the sorting of students into course levels where they receive markedly different curriculum and instruction. This new structure is referred to as ability grouping and has been prevalent in schools since the 1970s. Most recently, additional concerns about equal access and opportunity to learning experiences in combination with current research on teaching and learning have led some schools and districts toward the elimination of ability grouping. While many schools have been successful at eliminating ability grouping, many schools have also failed in their attempt, mainly due to their failure to address the social and political support for the institutionalized practice. As such, most schools continue to sort students into different course levels.

Review of Detracking Literature

The purpose of this chapter is to review literature on how the problems associated with ability grouping can be addressed in secondary schools. While there is considerable variability between interventions, they all attempt to create more equitable practices to ensure all students, regardless of their race or socioeconomic background or their academic ability, have access to high quality teachers, instruction, and resources. Three interventions emerged from the literature: (1) fix ability grouping practices to ensure it works as intended; (2) provide students choice for course selection; or (3) eliminate ability grouping by creating heterogeneous classes. Each of these interventions is reviewed in the following sections and when available, research and viewpoints of opposing sides are presented. After reviewing the interventions, literature highlighting institutional barriers and stakeholder resistance associated with changing current grouping practices is explored.

Fix Ability Grouping Practices to Ensure they Work as Intended

Some proponents of ability grouping believe current practices can be fixed to eliminate the negative consequences associated with the practice. Hallinan (1994) argues that current grouping practices are not performed as intended and thus create educational inequities. First, she identifies that the assignment of students into tracks is not entirely based on objective measures but rather on non-cognitive factors such as student work ethic, class participation, and interest. The use of these subjective factors can lead to the inequitable placement of students based on teacher biases and perceptions of student ability (Aschbacher, Li, & Roth, 2010; Ferguson, 2003; Tenenbaum & Ruck, 2003; Hallinan, 1994; Oakes, 2005). As such, Hallinan (1994) argues that only objective measures such as standardized test scores should be used when making course placement decisions. While Hallinan asserts groups will continue to be segregated by race and class, schools can counter this problem by “integrating students in their untracked classes and in other school activities… to lessen the negative effects” (Hallinan, 1994, p. 81). To counter the negative social dynamics created by tracking, Hallinan (1994) suggests that schools create structures and processes such as a reward system to enhance the social status of students in lower-level courses. In addition, to address instructional inequities, Hallinan (1994) suggests that school administrators ensure that teachers deliver challenging curriculum and instruction for lower-level students by increasing expectations and accountability. Further, schools should create flexible sorting policies that allow students to be reassigned to levels throughout the school year to preserve the homogeneity of classes (Hallan, 1994).

In opposition to Hallinan's viewpoint, Oakes (1994) asserts that ability grouping cannot be repaired because it is deeply connected to social and political influences that drive educational inequality. In her study of course placement processes in 16 high schools, Oakes (1994) describes there is "consistent evidence that background factors, including the discriminatory placement of minority students in low tracks, also come into play" (Oakes, 1994, p. 87). As such, schools will struggle to embody social justice through the mechanisms described by Hallinan (1994) but rather will require much deeper changes in grouping structures and the "norms and political relations these structures enact" (Oakes, 1994, p.87). In addition, Oakes (1994) purports that establishing sorting practices that use only objective factors will be ineffective as middle and upper class parents will use their social and political power to ensure their children are placed in higher-level courses. As a result, minority and lower socioeconomic students will remain inequitably placed in lower-level courses.

Provide Student Choice for Course Selection

In other attempts to correct the problems associated with ability grouping many schools have changed their course placement processes to include student choice in course enrollment (Yonezawa, Wells, & Serna, 2002). Similar to the "fix ability grouping" intervention, student choice attempts to address the processes associated with ability grouping. In this case, however, student choice is intended to increase the heterogeneity of course levels to create mixed ability courses. Proponents of this intervention believe that providing students with the opportunity to choose their course level will provide students with equitable access to high-level curriculum and instruction. Supporters also believe that choice will eliminate inequitable placement practices that results from teacher and counselor biases.

In a three-year, longitudinal case study of 10 racially and socioeconomically diverse secondary schools, Yonezawa, Wells, and Serna (2002) conducted 423 interviews with school stakeholders to identify the impact of student choice on course enrollment decisions. The researchers concluded that "offering choice without altering prevailing track hierarchies was unsuccessful because tracking is supported by a complex interdependence of structures and reinforcing cultural assumptions that students vary in ability, which in turn, influences students' identities and actions" (Younezawa, Wells, Serna, 2002, p. 38). They found that low-tracked students, particularly minority and low socioeconomic students, did not take advantage of the opportunity to enroll in high-level courses. Rather, previously low-tracked students identified themselves as having low-abilities and therefore self-selected lower-level courses. In addition, students shared a determination to not leave the "safe spaces they know in low- and middle-tracked classes, made up mostly of minority students, for seats in majority-Caucasian honors course where they felt unwelcomed" (Yonezawa, Wells, & Serna, 2002, p. 59). These strongly held beliefs by students led the researchers to conclude that schools must explicitly address these beliefs when attempting interventions designed to change current course-level structures or placement processes.

Eliminating Ability Grouping (Detracking)

Interventions that eliminate ability grouping (also referred to as detracking) by creating heterogeneous courses have received the most attention from researchers. Proponents of heterogeneous courses believe that students in these classes receive higher-level instruction, expectations, feedback, and opportunities to engage in critical thinking, inquiry, and discourse. The variability between detracking strategies, however, has made it difficult for researchers to determine the effect of heterogeneous classes on student achievement and the noncognitive factors important for learning such as self-efficacy, motivation, and engagement. Quantitative studies have shown mixed effects for detracking, with some identifying both positive (Alvarez & Mehan, 2006; Kissoon-Singh, 1996; Oakes, 1995; Slavin, 1995; Rui, 2009; Burris, 2014; Burris, Heubert, & Levin, 2006) and negative (Allen, 1991; Brewer, Rees, & Argys, 1995; Kulik, 1991; Nomi & Allensworth, 2014; Scott, 1993) results. Qualitative studies tend to focus on the perceptions of students and teachers about detracking (Yonezawa, Wells, & Serna, 2002; Yonezawa & Jones, 2006; Watanabe, 2006) or the social and political opposition to detracking strategies (Oakes, 2005; Wells & Serna, 1996; Welner & Burris, 2006). While all of these studies provide important insight for schools considering detracking, this section will highlight a selection of the most salient interventions to African American STEM education within the body of literature.

Burris, Heubert, and Levin (2006) studied a Long Island school district's detracking of their middle school math classes over multiple years beginning in 1995.

The detracking strategy included the elimination of ability grouping, implementation of new challenging curriculum, establishment of after school support for struggling students, and creation of common planning time for mathematics teachers. The researchers studied the detracking effort of the district by examining six cohorts of 152 to 181 students over a 6-year period. The researchers examined the effect of heterogeneous classes on high school math completion of precalculus and student achievement on the precalculus state math exam for low-achieving and high-achieving students. Results of the study show the percentage of initially low-achieving student completion of precalculus increased from 19 percent to 35 percent, exceeding the national average of 26.7 percent. Similarly, the percentage of high-achieving students successfully passing the state precalculus exam increased from 81 percent to 96 percent. The results of this study have important implications for schools considering a detracking intervention. It shows that if challenging curriculum is held constant and supports are in place to assist struggling students, detracking has positive effects for both low- and high-achieving students.

Watanabe, Nunes, Mebane, Scalise, and Claesgens (2007) conducted a mixed methods study to examine the classroom characteristics of two chemistry classes that were detracked in a racially diverse, public high school in California. Over a four year period, the researchers interviewed the detracked teachers and students, conducted a total of 32 classroom observations, observed teacher inquiry group meetings that explored topics related to ability grouping, and reviewed teacher journals that recorded teachers' experiences throughout the study. Quantitative data was also analyzed from pre- and post-test data to show that students made significant progress in their understanding of chemistry concepts. Through their qualitative strand, the researchers identified four beliefs and instructional practices that were essential to the students' progress:

1. Teachers' true belief in a developmental, as opposed to fixed, conception of ability and intelligence.
2. A focus on an inquiry-based and student-centered approach to chemistry using real-world contexts.
3. A focus on teaching students study skills.
4. A strong sense of community in the classroom, where students are held responsible for their own and each other's learning. (Watanabe et al., 2007, p.693)

These results provide important insight for schools considering detracking strategies. Since many detracking strategies fail to achieve desired goals, Watanabe et al. (2007) highlight the need for schools to focus on teachers' beliefs about student ability and specific classroom strategies that work in heterogeneous classes. These findings directly address the problems associated with teachers' lower expectations and perception of African American student ability (Ferguson, 2003; Francis, 2012; Tenenbaum & Ruck, 2007; Oakes, 2005).

Nomi and Allensworth (2014) examined the effect of student sorting practices in the Chicago City School District over a 10-year period. During this time, the Chicago school district implemented two different sorting practices for algebra education: (1) mixed ability classes; and (2) skill-based sorting practices that divided students by skill level offering the same curriculum standards but different instructional time for both low-achieving (received two periods of instruction) and high-achieving (received one period of instruction) students. The researchers found that skill-sorting "led to higher average achievement overall; low-skilled students have slightly lower test scores with sorting, while high-skilled students have substantially higher test scores, leading to higher average test scores with sorting" (Nomi & Allensworth, 2014, p. 5). In addition, results identify that test scores for high-achieving students declined when enrolled into mixed ability classes. The researchers share that the Chicago school district provided teachers with limited professional development on instructional strategies, mainly to address possible problems associated with the double period math classes for skill-sorting practices. The district did not address teachers' beliefs about student ability, inclusive instructional practices, or support for struggling strategies, all of which have been shown to be important components of successful detracking strategies (Oakes, 2005; Rubin, 2006; Wanatabe et al., 2007).

In a meta-analysis of 52 studies, Kulik and Kulik (1982) studied the effect sizes of ability grouping on student achievement. The average significant ($p<.05$) effect size of ability grouping in the 52 studies on student achievement gains was positive, but small ($d=.10$); however, the variation of effect size between studies was significant, ranging from -1.5 to 1.5. As such, the effectiveness of ability grouping varies widely from significantly effective to significantly ineffective. This suggests that factors associated with the groupings should be considered, such as the relative effectiveness for low and high-achieving students. These factors could explain the variation in effect sizes identified in Kulik and Kulik's (1992) study. This study has been criticized for not addressing the effect of ability grouping on low achieving students or disaggregating results based on the type of intervention. It also does not provide information on studies that found a negative effect size of ability grouping on student achievement.

In a more recent study, Rui (2009) completed a meta-analysis of major detracking studies to examine the effect size of heterogeneous grouping on K-12 student achievement. Rui (2009) reviewed 15 studies conducted over the past 35 years that report on the effects of detracking in the United States and in Canada. Results from this study "provide evidence that detracking practice had moderately positive effects on the academic outcomes of low-achieving students, and no significant effects on the academic outcomes of high- or average-ability students" (Rui, 2009, p. 181). In addition to analyzing student achievement, the study also identified the impact of heterogeneous groupings on non-academic student factors. For example, Rui (2009) found that students of both low- and high-achievement showed higher self-efficacy and more positive attitudes in mixed ability classes. While these results indicate that heterogeneous grouping show significant positive effects on lower-achieving students (d=.627) without harming higher-achieving students (d=.075), the authors caution school administrators to consider specific school contexts when designing detracking strategies. In addition to changing course structures, the authors identify the most successful detracking strategies also include "challenging the status quo and the basic norms, policies, and practices that have traditionally governed schools" (Rui, 2009, p. 181). These conclusions support theories of institutionalism whereby existing institutional practices are difficult to change and require attention to both the political and social climate of the institution and stakeholders (Meyer, 2006; Meyer & Rowan, 2006; Welner & Oakes, 2000).

One study in Rui's (2009) analysis identified particularly high effects of mixed ability classes on high achieving student achievement. In this study, Kissoon-Signh (1996) examined a sample of seventh grade students (n=130) in mixed ability science classes that supported cooperative learning and computer-based learning activities. The researcher found that mixed ability science classes have a significantly large effect on high ability (d=1.772) and average ability (d=3.543) student achievement. These results are in contrast to other studies that identify minimum to no effect on high ability students (Slavin, 1990). The difference between studies may be that Kissoon-Signh used a unique computer-based intervention model that has not been replicated. In addition to significant gains in student achievement, Kissoon-Signh (1996) also found that students of average ability had significant gains in perceived self-efficacy where high ability students did not differ significantly from their peers in homogeneous classes.

Institutional Barriers and Stakeholder Resistance

Tracking and ability grouping has persisted in most schools for over thirty years despite a considerable amount of research showing its negative effect on minority and lower-socioeconomic student achievement. Institutional theory helps explain the entrenchment of ability grouping by examining how strong government and societal forces control school structures, processes, and practices (Meyer, 2006). The social elite who hold economic, political, and cultural capital within school communities often resist changes to school structures and processes because their children enjoy the privileged status of current practices (Powell, 1991; Wells and Serna, 1996). In a qualitative study examining school organization, grouping practices, and classroom pedagogy, Wells and Serna (1996) studied ten secondary schools that were undergoing detracking reform. The schools ranged in size, demographics, and location in the United States and over 400 administrators, parents, teachers, students, and community leaders were interviewed over a three-year period. The researchers found that social elite, consisting of mostly

Caucasians and Asians, have “internalized dominant, but often unspoken, beliefs about race and intelligence and resist “desegregation” within racially mixed schools… because they do not want their children in classes with Black and Latino students” (Wells & Serna, 1996, p. 96). These beliefs have powerful implications for schools considering detracking and are the reason why many schools have failed in their attempt to detrack (Oakes, 2005; Watanabe et. al, 2007; Welner & Oakes, 2000).

In *Navigating the Politics of Detracking*, Welner and Oakes (2000) discuss resistance to detracking strategies and how reforms can overcome these barriers. They assert that most failed attempts to detrack schools resulted from reformers’ failure to address political and social opposition to change.

> Reformers tend to share two perceptions: (1) they overwhelmingly see tracking and, therefore, detracking as organizational issues, and (2) they see detracking as equitable and educationally beneficial. Both of these perceptions have strong basis in reality. However, they both can also lead would-be detrackers into dangerous missteps, with the potential to doom the reform (Welner & Oakes, 2000, p. 16).

Supporters of tracking, whether they are parents, students, teachers, or administrators, view detracking as a threat to the benefits associated with high-level courses (Welner & Oakes, 2000; Oakes, 2005). These courses provide students with challenging curriculum and instruction and produce the highest chances for college admission. Teachers enjoy these classes because there are less behavior problems and they perceive students to have a greater degree of motivation. Students form friendships in these classes and feel comfortable in high-level course environments. Parents support high-level classes not just for the challenging curriculum and instruction, but also the elitist status associated with enrollment in high-level courses. As such, parents, students, and teachers often view detracking as taking away these privileges that often lead to significant political and social opposition to detracking reform (Welner & Oakes, 2000).

To address these social and political barriers to detracking reform, the literature on detracking strategies suggest that school practitioners should: (1) prepare stakeholders for change by addressing stakeholders' beliefs and perceptions of student ability and intelligence; (2) slowly phase out lower-level courses and quickly find positive results; (3) provide academic support for students not prepared for rigorous course work; (4) implement inquiry-based and collaborative instructional strategies while maintaining high levels of challenge and enrichment.

To prepare stakeholders for detracking reform, school practitioners should form a parent advisory group to discuss and explore topics associated with heterogeneous classes and the research on mixed ability courses (Welner & Oakes, 2000). In addition, teacher inquiry groups should be created to provide teachers with an opportunity to share ideas and beliefs about mixed ability classes (Watanabe, 2006) and to provide professional development on instructional strategies such as differentiated instruction and Universal Design for Learning (Nomi & Allensworth, 2014). Most importantly, teachers' "biases, prejudices, and snap-judgments about children" should be addressed so that they truly believe each child should be academically challenged at a high level (Welner & Oakes, 2000, p. 17) and that student ability is a product of effort and not of innate ability (Boaler, 2006). For individual schools attempting detracking reform, school leaders must have support from directors and superintendents who are willing to confront student and parental opposition (Welner & Oakes, 2000). Student beliefs about ability and intelligence as well as race and ethnicity should be explicitly addressed in heterogeneous classes. Yonezawa, Wells, and Serna (2002) argue that "classrooms where identities, roles, and interactions are broken down and reconstructed in ways that allow all participants to redefine themselves and their relationships with each other" will result in a more inclusive and respectful environment for all students (Yonezawa, Wells, and Serna, 2002, p. 62). In a four-year study of the detracking efforts of three U.S high schools, Boaler (2006) collected 600 hours of classroom observations, student and teacher questionnaires, and interviews. Boaler (2006) found the schools that directly addressed student perspectives of culture and race learned to "appreciate the contributions of students from different cultural groups, social classes, genders, and attainment levels, and developed extremely positive intellectual relationships" (p. 41).

Burris and Welner (2005) describe the successful detracking strategy used in a New York state school district. The district purposefully detracked courses over a number of years to gradually implement the reform. Their first cohorts included 9th grade English and social studies classes and 8th grade science classes. After the first year, teachers of the detracked courses were pleased with the results and the district used this data to support additional detracking of all 9th grade courses. This process continued and within five years, all courses in the district were detracked. The gradual detracking process used by the district is consistent with other reports suggesting that schools do not "rush" detracking but rather systematically and gradually detrack their courses (Oakes, 2005; Rubin, 2006; Welner & Oakes, 2000).

Schools that have successfully detracked have implemented academic support for initially low-achieving students. Alvarez (2006) describes one school's reform strategy and asserts, "A central tenet of the school is that students have a variety of supports to meet the challenges of the rigorous curriculum" (p. 85). Likewise, Rubin and Noguera (2004) argue that "In order to insure the success of detracking, it is critically important that lower achieving students be given the support they need to reach higher expectations, or these students will not be able to access the new learning opportunities provided by more demanding courses" (p. 98). While some support strategies include remediation and tutoring, it is advised by many researchers that teachers work to build inclusive learning environments within the classroom to support initially low-achieving students. For example, Ladson-Billings (1995) found that teachers who implemented culturally relevant pedagogy were much more successful with African American students, producing significantly higher achievement levels.

Recent research on detracking reform tends to focus on the instructional strategies teachers use to ensure all students are successful in heterogeneous classes. Freedman, Delp, and Crawford (2005) describe a number of underlying principles that teachers can use for instructional planning in detracked classes. These principals include: (1) spiraling curriculum that leaves room for increasing levels of complexity; (2) developing student-centered lessons that place the student in control of their learning; (3) building a learning community that respects and makes productive use of diverse contributions from a variety of learners; (4) differentiating instruction to meet the needs of all students; (5) providing support for students as needed; (6) delivering high level of challenge for all students; and (7) maintaining active student engagement. Watanabe (2007) describes the successful implementation of this framework in detracked high school chemistry classes. The chemistry teachers focused on implementing an inquiry-based and contextual pedagogy that provided students with opportunities to draw on their previous knowledge and collaboratively engage in challenging problem solving. This approach is consistent with other studies that show student-centered and inquiry-based instructional strategies increase student engagement and achievement in science (Meyer & Crawford, 2011). In addition, the teachers in Watanabe's et al. (2007) study explicitly taught students study skills such as note taking, studying, and reading from texts. These instructional strategies increased students' confidence in their ability to learn chemistry and for completing complex academic tasks. A similar result is seen in Boaler's (2006) study where teachers provided students with what they call *group-worthy problems* – "open-ended problems that illustrate important mathematical concepts, allowing for multiple representations, and have several possible solution paths" (p. 42). Boaler (2006) argues that when students are provided many ways to be successful then many more students will be successful.

Summary of Detracking Literature

Ability grouping creates inequitable opportunities for secondary student learning, segregates diverse schools by race, ethnicity, and social class, and precludes lower-tracked students from pursing post-secondary degrees in STEM. While there is a large body of research identifying the negative effects of ability grouping on low-tracked students, most schools continue to group students into course levels. The districts and schools that have attempted to change grouping practices have seen various levels of success. These successes and failures have begun to establish a set of best practices for schools to follow as they plan for detracking. The most successful strategies include the gradual elimination of ability grouping by creating mixed ability classes that implement inquiry-based, student-centered, and differentiated instruction. In addition, successful interventions include professional development that address teachers' biases and perceptions of student ability and intelligence, and strategies for developing student self-efficacy, growth mindset, interest, and motivation in coursework. They also include support structures for initially low-achieving students to close content and skills gaps between students. Finally, all successful interventions directly confront oppositional resistance from stakeholders by sharing supporting evidence for mixed ability courses and providing opportunities for stakeholders to explore their beliefs about ability grouping.

Chapter 5: Intervention Design and Methodology

Intervention Design

The intervention was implemented at the same high school where the needs assessment was conducted (see chapter 3) from August 2016 and to January 2017. The school is located in the Mid-Atlantic United States and serves 2,147 in grades 9-12. School demographics include 28 percent African American, 28 percent Caucasian, 18 percent Asian, 20 percent Hispanic, and 6 percent Multiple Race students. The intervention employed a mixed methods study that addresses the inequities created by ability grouping. An embedded design was used in which both qualitative and quantitative data were embedded within a major design intervention trial. Creswell and Clark (2011) explain, “The embedded design is a mixed methods approach where the researcher combines the collection and analysis of both quantitative and qualitative data within a traditional quantitative research design” (p. 90). The purpose of the embedded design in this study was to examine the implementation processes of the intervention and to explain the reactions, perceptions, and values of participants in the experiment. In an embedded design, the qualitative strand may occur before, during, and/or after the quantitative data collection (Creswell & Clark, 2011). In this study, qualitative data was collected throughout the study to examine the implementation of the intervention and at the conclusion of the study to measure participants’ reactions to the intervention.

The quantitative data in this study was used to test the theory that predicts that honors-level mixed ability chemistry classes will positively influence student achievement, interest in science, self-efficacy, and engagement for African American and all other students at the high school. The qualitative data was embedded in this larger design intervention trial for the purpose of measuring teacher and student perceptions and value of their participation in mixed ability classes. The intervention included: (1) creating two mixed ability honors chemistry classes (n=64 students) that employed inquiry-based, student-centered, and differentiated instruction; (2) addressing teachers' beliefs about African American ability, motivation, and intelligence through professional development; (3) supporting initially low achieving students who demonstrate gaps in essential content and skills by providing teachers with student instructional aides; and (4) developing student self-efficacy through teacher professional development on topics including race, equity, cultural proficiency, student goal setting, praise for effort, high expectations, student self-reflection, and growth mindset.

The intervention's short-term outcomes included increasing student achievement in chemistry by ensuring that all students, regardless of their race, ethnicity, or socioeconomic background, have access and opportunity to high-quality instruction, curriculum, and resources. In addition, high-level heterogeneous classes and teacher professional development were used to increase student interest in science, self-efficacy, and engagement compared to students in traditional homogeneous classes.

Long-term outcomes included increasing student enrollment and success in post-secondary STEM programs. Students who are successful in secondary high-level science courses and have an interest in STEM are much more likely to pursue post-secondary degrees and careers in STEM (Maltese & Tai, 2011; May & Chubin, 2003). As such, if African American students are successful in the heterogeneous honors chemistry class then they will have the opportunity to take additional high-level science courses in high school. Enrollment in these higher-level courses will provide African American students with access into the STEM pipeline.

Research Questions

1) What is the effect of heterogeneous honors chemistry classes on student achievement?
2) How does participation in a heterogeneous honors chemistry class influence students' enrollment in advanced level science classes?

Process Evaluation Questions

1) To what extent is the intervention implemented with fidelity?
2) What is the impact of the intervention on participants' perceptions and value of heterogeneous classes?

Hypothesis

Heterogeneous honors chemistry classes will significantly ($p<.05$) increase student achievement across time and condition and provide them access into the post-secondary STEM pipeline.

Methods

Participants and Sampling

The intervention used a quasi-experimental design with two conditions. To be included in the study, students must have requested enrollment into on-level or honors chemistry for the 2016-2017 school year. Students were general education students and were not enrolled in the school's special academic programs. Students must also have taken both the Measures of Academic Progress in math (MapM) and reading (MapR) in the spring of their 8^{th} grade year. Of the total 556 students who requested enrollment into chemistry, 190 students were excluded leaving a possible sample of 366 students. Using this eligible sample, students were divided into quartiles by the sum of their MapM and MapR scores. Sixteen students from each quartile were randomly selected to participate in the treatment condition resulting in a total of 64 student participants. Once the treatment condition was created, a matched sample was selected by the researcher to be included in the control condition. Each student's combined Map score, race, sex, socioeconomic status, and course level request was considered when creating the matched sample. The total number of participants included 128 students after sampling both conditions.

The sixty-four students selected for treatment were randomly assigned to one of the two chemistry course sections. A teacher was randomly assigned to each treatment section. The sixty-four students selected for the control were assigned by scheduling software into non-treatment classes. These students were enrolled into the chemistry course level they requested (i.e., on-level or honors) and were mixed into classes with students not participating in the study.

Two teachers were selected to teach one section of the treatment condition. One of the treatment teachers had 20 years of teaching experience and the other had 5 years of experience. Both teachers were female and were selected because of their interest in teaching a heterogeneous section of chemistry. Four other teachers were scheduled to teach students of the control condition. Two of the teachers transferred out of the school just prior to the school year. The school hired two first year teachers, one male and one female, to teach chemistry and both teachers agreed to participate in the study. The other two teachers, one male and one female, had 20 and 15 years of teaching experience, respectively.

Student instructional aides were selected by their participation and performance in the school's Advanced Placement (AP) chemistry course and by teacher recommendation. The AP chemistry teacher generated a list of possible students and the list was reviewed by the study's treatment condition teachers. Four students were selected from the list to become instructional aides and all four students agreed to participate in the study. One student was not able to participate as an instructional aide because of scheduling conflicts. The remaining three students, one male and two females, participated in the study. Two students supported one of the treatment condition classes and one student supported the other treatment condition class. The role of the student instructional aides was to support classroom instruction by providing one-on-one support for students who need assistance, clarifying teacher directions and explanations, and providing immediate feedback to students on their work by checking for student understanding throughout lessons. The instructional aides also assisted teachers with classroom management in regards to supporting lab and activity transitions.

Outcome Evaluation

Indicators for the outcome evaluation are illustrated in Appendix C. Both the treatment and control conditions took a pre-test on chemistry content and skills during the first week of school in August 2016. The treatment teachers created the test by selecting questions from the June 2015 and January 2016 administration of the New York State Chemistry Regents exam. Questions were selected based on the curriculum that was covered in honors chemistry classes from August 2016 through January 2017. When selecting questions, teachers used all questions of a given topic so not to exclude questions of the same topic. Both students in the treatment and control conditions took the same exam in January 2017 at the conclusion of the treatment. A split-plot analysis of variance (ANOVA) controlling for initial achievement levels was used to identify significant differences across time (pre- to post-test), interactions between time and condition, and differences between conditions for the full sample and by quartile, race, and initial course level recommendation made by teachers. A post-hoc one-way ANOVA was used to further examine the differences in pre- and post-test scores between conditions. In addition to reporting significance levels from inferential statistics, methodologists suggest researchers should "use magnitude-of-effect estimates in result interpretation to highlight the distinction between *statistical* and *practical* significance" (Synder & Lawson, 1993, p. 334). As such, effect sizes were calculated (omega squared) to identify the magnitude of the variance between the two conditions where differences were statistically significant.

Process Evaluation

Fidelity of intervention evaluation may be defined as how well the implementation of the intervention aligns to the researcher's originally planned protocols and program model (Nelson, Cordray, Hullenman, Darrow, and Sommer, 2012). Research effectiveness is no longer measured exclusively by "black-box" outcomes; rather, it is measured by the validity and reliability of criteria for establishing fidelity to the researcher's model. Nelson, Cordray, Hullenman, Darrow, and Sommer (2012) purport, "Intervention fidelity fully opens the black-box by measuring the processes linking implementation and outcomes" (p. 378). This description of fidelity by Nelson, et al. (2012) requires the researcher to develop a five-step process to assess the fidelity of an intervention: (1) develop an intervention model; (2) identify indices for each program activity; (3) ensure validity and reliability; (4) develop multiple measures for each activity and output; and (5) link fidelity to outcomes. These steps are followed to identify fidelity criteria in this study and are explained in more detail below.

Intervention model

An intervention model illustrates a theoretical or causal relationship between program activities, outputs, and outcomes. In this evaluation, the intervention model is represented in both a logic model and causal-diagram (Figures 2 & 3). The logic model operationalizes constructs by describing the study’s activities and intended outputs. For example, the logic model in Figure 2 identifies that professional development will be provided to teachers once a week and that student engagement, interest in chemistry, and self-efficacy are some of the intended outputs. While the logic model exposes intervention structures and processes, the causal diagram illustrates assumed causal relationships between variables (Figure 3). For example, the causal diagram in Figure 3 identifies that teacher professional development is expected to influence teachers’ knowledge, skills, and beliefs, which in turn influences students’ self-efficacy and engagement. As such, the causal diagram provides more detail about intervention processes and supports the identification of appropriate fidelity indicators in step 2.

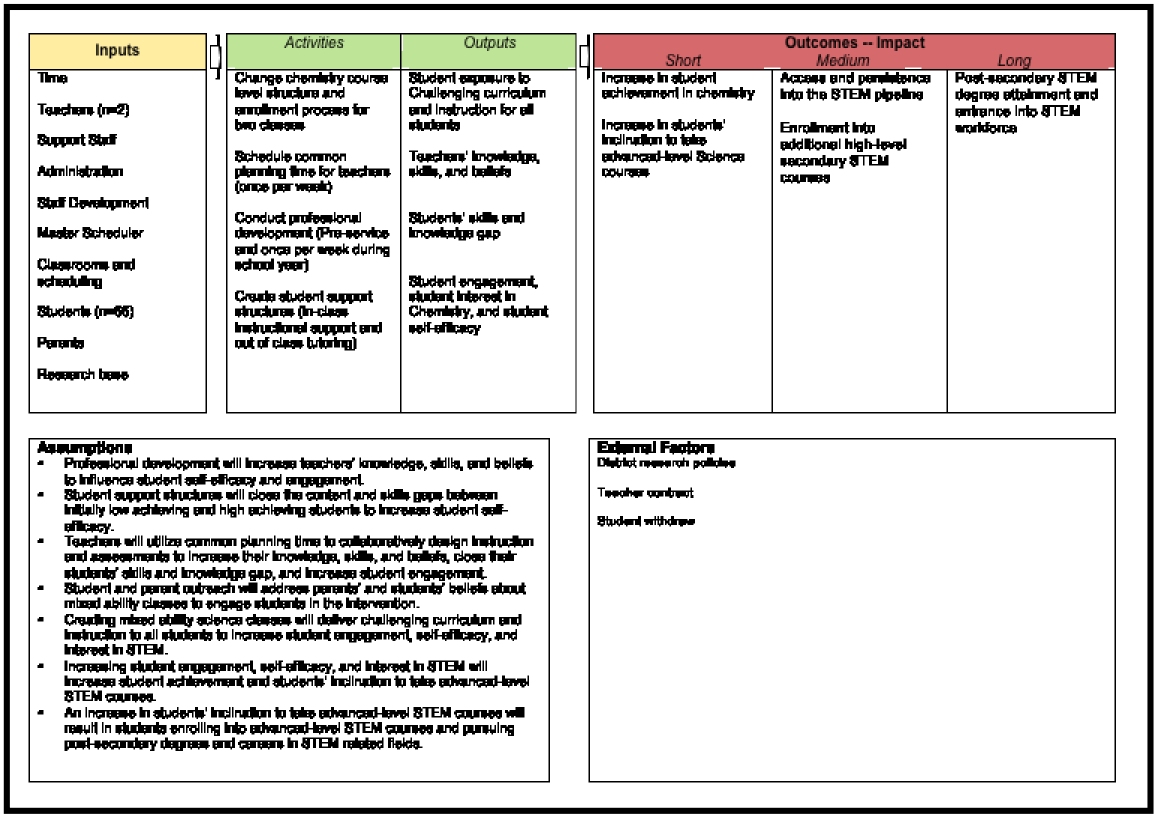

Figure 1 *Logic Model*

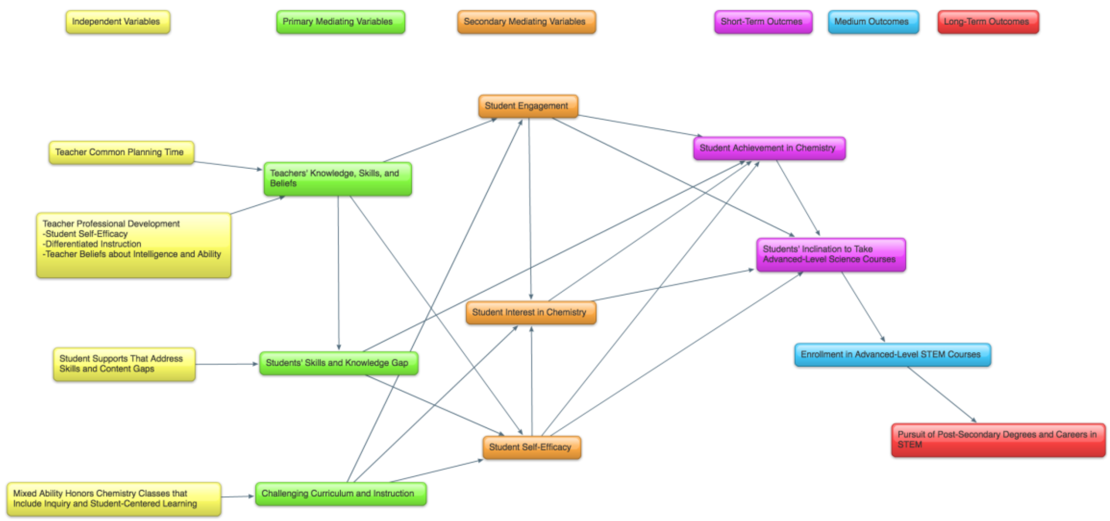

Figure 2 *Causal diagram depicting the relationship between independent variables, mediating variables, and outcomes.*

Indices for program activities.

Indices for the program's activities were created to measure the degree that they are implemented with fidelity (Nelson et al., 2012). These indicators seek to identify information about the adherence, dosage, quality of program delivery, participant responsiveness, and program differentiation (Dusenbury, Brannigan, Falco, and Hansen, 2003). In addition, indices were also created to measure the impact of activities on outputs. These indicators provide important information on the quality of program delivery and program differentiation (Dusenbury et al., 2003). Appendix D identifies the fidelity indicators for this study. Each construct represented in the logic model and causal diagram has been assigned an indicator to measure the fidelity of implementation and the effect on outputs. A full description of each indicator follows. Survey data were analyzed using descriptive statistics.

Teacher professional development on student self-efficacy.

Teachers in the treatment group were provided professional development on how to increase student self-efficacy. Teachers participated in a two-hour online professional development module created by Siegle (2000) on student self-efficacy and ways in which the teachers can increase student self-efficacy. The professional development occurred over the summer prior to the start of the school year. The online modules were adapted from Siegle's (1995) teacher professional development on student self-efficacy titled "Making a Difference: Classroom Strategies to Motivate Students." In a study of 8 schools and 442 students, Siegle (1995) found that students of teachers who received professional development on student self-efficacy showed significantly higher mathematics scores after 4 weeks than students of teachers that did not receive training. In his study, Sielge (1995) confirmed the validity and reliability (Cronbach's alpha = .92) of the "Teacher Survey on Student Self-Efficacy" (see Appendix E). In addition to the survey, Siegle (1995) designed a "Daily Strategy Form" (see Appendix F) to identify the self-efficacy strategies teachers implemented throughout the intervention. Also, an open-ended 8-item "Efficacy Awareness Form" (see Appendix G) was created to assess teachers' understanding of self-efficacy after they received professional development. Teachers in the treatment group completed the "Teacher Awareness Form" once after the professional development is completed. Teachers in the treatment and control groups completed the "Teacher Survey on Student Self-Efficacy" twice, once at the beginning and end of the study. Teachers in the treatment completed the "Daily Strategy Form" each day during the study to record the implementation of self-efficacy strategies. The researcher took attendance during each professional development session to measure the treatment dosage. Survey data were analyzed using descriptive statistics.

Teacher professional development on differentiated instruction.

Teachers in the treatment group were provided professional development on differentiated instruction to increase their knowledge and skills of how to deliver instruction to academically diverse students and to increase their self-efficacy for working with a wide range of learners (Dixon, Yssel, McConnell, & Hardin, 2014; Stone, 2012). Teachers in the treatment group read Carol Ann Tomlinson's (2001) "How to Differentiate Instruction in Mixed-Ability Classrooms" over the summer prior to pre-service week. Teachers met with the researcher prior to pre-service for two hours to discuss the differentiated strategies presented in the book. Additional discussions around the implementation of differentiated instruction strategies occurred monthly throughout the intervention and were recorded by the researcher.

Prior to reading "How to Differentiate Instruction in Mixed-Ability Classrooms" teachers in the treatment responded to selected items in the "Ohio State Teacher Efficacy Scale (OSTES)" (see Appendix H) designed by Tschannen-Moran and Woolfold Hoy (2001). The survey was tested for validity and reliability (scores on OSTES were positively associated to previous metrics ranging from r=.028 to r=.048) across three studies of 624 in-service and pre-service teachers. Results were found to be "superior to previous measures of teacher efficacy in that it has unified and stable factor structure and assesses a broad range of capabilities that teachers consider important to good teaching" (Tschannen-Moran & Woolfold Hoy, 2001, pp. 801-802). Teachers in the treatment also responded to survey items at the end of the intervention. In addition, teachers in the control responded to survey items at the beginning and end of the study for comparison to the treatment. The observer recorded teacher attendance at common planning meetings. Survey data were analyzed using descriptive statistics.

Teacher professional development on students' ability and intelligence.

Teachers received professional development on how to develop student growth mindsets. Students that hold a growth mindset (belief that their intelligence and ability can be increased through effort) have significantly greater achievement in school than students who hold a fixed mindset (Dweck, 2006). In addition, teachers that receive professional develop on mindsets are effective in changing their students' mindsets (Dweck, 2006; Dweck, 2016). Teachers in the treatment group read "Mindset: The New Psychology of Success" over the summer prior to the start of school. The researcher engaged teachers in conversations about the content of the book during weekly common planning times as teachers planned to incorporate strategies that develop student growth mindsets into their lessons. The researcher recorded the conversations at the common planning meetings and conducted six classroom observations of the treatment group to examine the extent to which the strategies are implemented. Prior to reading "Mindset: The New Psychology of Success," teachers in the treatment group responded to the questionnaire, "Measuring Mindset," designed by Carol Dweck (2016) (see Appendix I) to determine their understanding and belief about mindsets. Teachers responded to the survey again at the conclusion of the study. Teachers in the control group also responded to the survey items at the beginning and end of the study for comparison to the treatment group. The researcher conducted six classroom observations of the control group and recorded teacher attendance at common planning meetings. Survey data were analyzed using descriptive statistics.

Student engagement.

Student engagement has been found to be significantly associated with school achievement levels (Appleton, Christenson, Kim, & Reschly, 2006). In addition, teachers' knowledge, skills, and beliefs as well as challenging curriculum and instruction can influence student engagement (Wantanabe, 2007). Appleton et al.'s (2006) "Student Engagement Instrument" (see Appendix J) was modified to measure student engagement in their chemistry classes. The 35-question, self-report survey was designed by the researchers and tested for validity and reliability (survey items positively correlated to academic variables including GPA and math and reading achievement) with 1,931 ninth grade students in a large, diverse, urban school district. Appleton et al.'s (2006) questions apply to general school engagement and therefore were modified to apply to chemistry classes. For example, survey question 3 was changed from "At my school, teachers care about students" to "In chemistry class, my teacher cares about students." Both the treatment and control groups responded to the survey items at the end of the study. A t-test of independent samples was used to test the null hypothesis that there is no significant difference between conditions at a confidence level of 95%.

Student interest in chemistry.

Students' perception of and interest in science is associated with the likelihood that they pursue post-secondary degrees and careers in STEM (Maltese & Tai, 2011; Moore, 2006). The assumption in this study was that challenging curriculum and instruction and increased student engagement and self-efficacy will increase student interest in chemistry. As such, students responded to a modified "STEM Semantics Survey" (see Appendix K) created and assessed for validity and reliability (Cronbach's alpha = .93) by Tyler-Wood, Knezek, and Christensen (2010). The “STEM Semantics Survey” included questions on science, math, engineering, technology, and careers in STEM. Questions related to science and science-related career aspirations and interest have been selected for the survey in this study. Students in both the treatment and control groups responded to survey questions at the beginning and end of the study. A split-plot ANOVA controlling for initial achievement levels was used to identify significant differences across time and condition and between the two groups for the full sample and by quartile.

Student self-efficacy.

Students with a greater sense of self-efficacy achieve at higher levels and hold more proactive and self-motivating behaviors than students with lower self-efficacy (Zimmerman, Bandura, & Martinez-Pons, 1992). It is assumed in this study that student self-efficacy will increase with teachers’ professional development on self-efficacy, support for initially low-achieving students, and participation in challenging curriculum and instruction. Students in both the treatment and control groups responded to a 12-item survey (see Appendix L) designed and assessed for validity and reliability (correlations to course grades ranged from $r = .22$ to $r = .41$) by Zimmerman, Bandura, and Martinez-Pons (1992) at the end of the study. A t-test of independent samples was used to test the null hypothesis that there is no significant difference between conditions at a confidence level of 95%. In addition, the researcher assessed the implementation of challenging curriculum and instruction during common planning meeting and classroom observations.

Dosage of intervention.

The dosage of the intervention was measured for both teachers and students. The researcher recorded attendance at professional development sessions and common planning times. Teachers took daily attendance using their online Gradebook.

Frequency of student support.

Supporting initially low-achieving students to address content and skills gaps is an essential component to effectively implementing mixed ability classes (Alvarez, 2006; Rubin & Noguera, 2004; Watanabe, 2007). This intervention provided in-class student instructional aides for chemistry students in the treatment group. The student instructional aides were upper-classmen who had successfully completed Advanced Placement Chemistry. The peer supporters attended the honors heterogeneous classes each day. Teachers took daily attendance of the peer supporters and the peer supporters completed a daily log to indicate which students they supported during the class. They also indicated the type of support provided to each student including (1) math concepts and computation, (2) content vocabulary and examples, (3) organization of materials, and (4) support with directions and processes. In addition to the peer support, teachers offered lunchtime and after school tutoring support to students. Further, the researcher noted the interaction between peer supporters and students during classroom observations.

Participant responsiveness.

The opinions of teachers and students on the structure and process of the intervention were recorded by semi-structured interviews with the two mixed ability teachers and six students of varying ability at the conclusion of the study. Twelve classroom observations were conducted (six for the treatment and six for the control) throughout the intervention to collect data on classroom structure and processes. The Reformed Teaching Observation Protocol (RTOP) was used for classroom observations. RTOP is a tested protocol for reliability (r^2 = .954 for multiple raters) and validity correlation between RTOP scores and normalized student achievement gains in multiple courses (r^2 = .88) (Pibum & Sawada, 2000).

Validity and reliability

The validity and reliability of each indicator must be assessed to support conclusions about casual relationships (Nelson et al., 2012). In this study, data collection protocols for each fidelity indicator have a high degree of validity and reliability as determined by previous research studies.

Multiple Measures.

Multiple indices were combined to evaluate each construct within the evaluation (Nelson et al., 2012). This study utilizes a mixed methods design that provided opportunities for measuring each fidelity indicator in multiple ways. For example, to measure the fidelity of teacher professional development on differentiated instruction, teachers completed a knowledge and skills survey on differentiated instruction and the researcher completed classroom observations to measure the degree to which differentiated instruction is implemented in the teachers' lessons.

Linking fidelity to outcomes.

In addition to traditional methods of measuring differences in outcomes among treatment and control groups, fidelity of implementation requires that "the difference between components implemented for treatment and control groups" is specified (Nelson, et al., 2012, p. 391). As such, fidelity indices are applied to both the treatment and control groups in this study. Comparing the fidelity indices of the treatment and control group strengthened conclusions about causal relationships between intervention activities, outputs, and outcomes.

Informed consent.

Informed consent was obtained for all participants in the study (See Appendices M-T).

Strengths and Limitations of Design

Random assignment is the "preferred method for obtaining a precise and statistically unbiased estimate of the effects of an intervention" (Shadish, Cook, & Campbell, 2002, p.277). Random assignment requires the researcher to make fewer assumptions than other methods and significantly reduces threats to both internal and external validity. This study used random assignment of students to the treatment group as the best possible design to sample students into the heterogeneous classes. The control group, however, was selected by the researcher to match the sample to the treatment group. The selection process for the control condition exposed the study to possible researcher bias, as decisions were made about which students most closely match the treatment. To reduce this bias, the researcher used a set of criteria to match students. For example, each student in the treatment group was matched with a student of the same sex, course request, race, socioeconomic status, and similar combined Map score. While the control group closely resembled the treatment group based on these criteria, the groups were not identical. There were variations among the matched samples that cannot be controlled for in this study. For example, parental involvement and support may influence students' achievement levels and act as a confounding variable in this study.

Other possible weaknesses of the design included the close collaboration between the treatment and control condition teachers. The chemistry team at the research site met once per week to commonly plan lessons and assessments. It was possible that the treatment teachers discussed the intervention's professional development with the control teachers. These discussions could have resulted in treatment diffusion where the control teachers implemented parts of the treatment and thereby reduced the effect size between conditions. This possible threat to construct validity was addressed by asking the treatment teachers to not explicitly share professional development materials with the control teachers; however, it is likely that some diffusion of information occurred across teachers during their weekly meetings.

It was challenging to control for teacher effects in this study as two of the control condition teachers transferred out of the study site just prior to the school year. Two first year teachers were hired by the school to teach chemistry and both teachers participated in the study. Significant teacher effects on student outcomes could have occurred as years of teaching experience was not controlled.

The experimental design measured the changes in multiple mediating variables including teachers' knowledge, skills, and beliefs, implementation of professional development strategies, and students' engagement, self-efficacy, and interest in science. As such, the causal relationships between these variables and the outcome were measured and compared between conditions. Comparing these variables between the treatment and control conditions strengthened the conclusions about the effect of the treatment on the outcomes.

Chapter 6: Findings and Discussion

Quantitative Results

Homogeneity and Normality

Prior to the primary statistical analysis, the data was examined for homogeneity of variance and normality. Certain data set assumptions, such as the normality of populations and homogeneity of population variances, must be satisfied if inferential statistical *F* test results are to be valid. When these assumptions are not met, "…control of the Type I error rate, the probability of erroneously rejecting a true null hypothesis, can be seriously jeopardized, as can statistical power, the probability of correctly rejecting a false null hypothesis" (Lix, Keselman, & Keselman, 1996, p. 579). To examine normality of the data set, SPSS was used to calculate skewness and kurtosis values for the pre- and post-chemistry tests (Table 9). The findings revealed that all skewness and kurtosis results were in acceptable limits (below +2.0 and above -2.0) as defined by Trochim & Donnelly (2006). To further examine the normality of test scores, residuals for chemistry test data were calculated by finding the difference between test score and test score means for the treatment and control pre- and post-tests (Table 10). SPSS was used to calculate the skewness and kurtosis for residuals and results were within acceptable limits (Trochim & Donnelly, 2006). Finally, SPSS was used to calculate z-scores of pre- and post- chemistry test scores. All z-scores were above the -3.29 and below the +3.29 thresholds confirming that chemistry test scores meet normality assumptions (Tabachnick & Fidell, 2008).

Levene's test was used to determine the equality of variance between the treatment and control group test scores. SPSS results for Levene's test of equal variances identified equal variances on chemistry post-test scores, $F(1, 114) = 9.902$, $p = .002$, and unequal variances on chemistry pre-test scores, $F(1, 114) = .281$, $p = .597$. While these results identified a violation of the homogeneity assumption for the chemistry pre-test scores, the effect of heterogeneity of variances on type 1 error was minimal. Lix et al. (1996), explain, "The severity of the effect of violating the variance homogeneity assumption is a function of whether group sizes are equal or unequal" (p. 582). Certain inferential statistical analysis tests, such as the analysis of variance (ANOVA) used in this study, are particularly robust to homogeneity violations, especially when sample sizes are equal (Lix, Keselman, & Keselman, 1996). However, according to Box (1954), the validity of *F* test values is also dependent on the spread of variances in addition to the equality of variance. As such, SPSS was used to calculate Box M scores to identify the equality of covariance between chemistry pre- and post-tests. Results were found to be non-significant for the chemistry test ($p = .390$), supporting the assumption that test score variance was homogeneous.

Table 9 *Skewness and kurtosis for full sample of pre- and post-chemistry test.*

	N	*M*	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Pre-Test	116	11.70	-.028	.225	1.385	.446
Post-Test	116	17.75	.206	.225	-.718	.446

Table 10 *Skewness and kurtosis for chemistry pre- and post-chemistry test score residuals.*

	N	*M*	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Pre-Treatment Residual	58	.0028	-.530	.314	1.806	.618
Pre-Control Residual	58	.0038	.772	.314	.886	.618
Post-Treatment Residual	58	-.0003	.080	.314	-.653	.618
Post-Control Residual	58	.0003	.523	.314	-.394	.618

Chemistry Achievement

Descriptive Statistics.

The Chemistry post-test mean is greater in the treatment group (M = 20.19, SD = 5.978) than in the control group (M = 15.31, SD = 6.247) for the full sample. This pattern is also observed in all four quartiles (Table 11). Means are also greater for the treatment group when disaggregated by initial course recommendation by the students' teachers. The post-test mean for students in the treatment group who were initially recommended for basic science (M = 14.75, SD = 3.167) are greater than the post-test mean (M = 11.19, SD = 3.167) for students in the control group. Similarly, the post-test mean for students in the treatment group who were initially recommended for honors science (M = 22.26, SD = 5.236) is greater than the post-test mean for students in the control group (M = 16.88, SD = 6.436). This pattern is also observed when the data is disaggregated by race. For example, the post-test mean for African American students in the treatment group (M = 16.18, SD = 4.760) is greater than the post-test mean for African American students in the control group (M = 11.95, SD = 4.696). The post-test mean for Caucasian students in the treatment group (M = 21.00, SD = 5.594) is greater than their peers in the control group (M = 16.00, SD = 6.505).

Table 11 *Descriptive statistics for pre- and post-chemistry test.*

		Pre-Test			Post-test		
		M	*SD*	*N*	*M*	*SD*	*N*
Full	Treatment	11.98	3.936	58	20.19	5.978	58
	Control	11.41	3.185	58	15.31	6.247	58
Quartile 1	Treatment	8.85	3.484	13	14.38	4.292	13
	Control	9.46	2.066	13	10.85	4.279	13
Quartile 2	Treatment	12.20	2.597	15	17.67	4.593	15
	Control	10.80	2.111	15	15.33	5.300	15
Quartile 3	Treatment	12.27	2.764	15	21.33	2.225	15
	Control	11.60	3.043	15	15.27	5.946	15
Quartile 4	Treatment	14.20	4.873	15	26.60	4.485	15
	Control	13.53	3.889	15	19.20	6.710	15
Recommended Basic	Treatment	8.94	4.281	16	14.75	3.167	16
	Control	9.38	2.156	16	11.19	3.167	16
Recommended Honors	Treatment	13.14	3.136	42	22.26	5.236	42
	Control	12.19	3.187	42	16.88	6.436	42
African American	Treatment	11.53	3.262	17	16.18	4.760	17
	Control	9.84	2.167	19	11.95	4.696	19
Caucasian	Treatment	13.67	3.962	12	21.00	5.954	12
	Control	11.45	2.395	20	16.00	6.505	20
Hispanic	Treatment	10.20	4.341	10	19.60	3.406	10
	Control	10.86	3.078	7	14.71	3.039	7
Asian	Treatment	12.53	4.230	17	24.47	5.680	17
	Control	14.17	4.130	12	19.83	6.713	12

Analysis of Variance.

A split-plot ANOVA examined the effect of time, treatment condition, and the interaction between the two on students' test performance. Findings are presented for the full sample and by quartile, initial course recommendation made by teachers, and race. Follow-up post-hoc analysis was conducted using a one-way ANOVA to further examine differences between students' performance on pre- and post-tests for both conditions. Proportions of variances (effect size) for between group differences were calculated using the omega squared formula, $\omega^2 = (SS_{effect} - (df_{effect})(MS_{error})) / MS_{error} + SS_{total}$ (Keppel, 1991). Fields (2013) suggests using omega squared values of .01, .06, and .14 to indicate small, medium, and large effects respectively.

The findings revealed a statistically significant effect of time on student test performance for the full sample, $F(1, 113) = 12.626$, $p = .001$, and a statistically significant interaction between condition and time for the full sample, $F(1, 113) = 21.626$, $p = < .001$, (Table 12). Figure 4 illustrates a positive effect of time on student test performance for both conditions and a greater effect of the treatment on student test performance compared to the control. Between subjects analysis identifies a significant difference and a medium effect size between treatment and control groups for the full sample, $F(1, 113) = 23.136$, $p < .001$, $\omega^2 = .094$, (Table 13). Post-hoc one-way ANOVA results show there is no statistically significant difference between the treatment and control groups at time 1 (pre-test) for the full sample, but there is a statistically significant difference at time 2 (post-test), $F(1, 114) = 18.470$, $p < .001$, with a medium effect size of $\omega^2 = .133$ (Table 14).

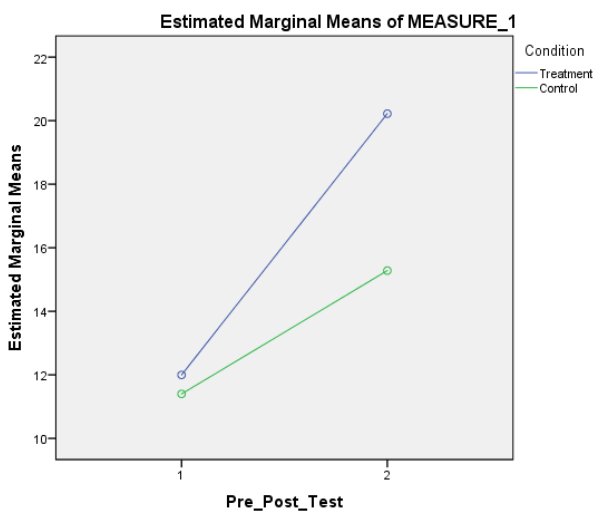

Figure 3 *Plot of full sample pre- and post-test means for treatment and control groups.*

When disaggregated by quartile, there is no statistically significant effect of time on the student test performance, but there is a statistically significant interaction between treatment condition and time in quartile 1, $F(1, 23) = 4.534$, $p = .044$; quartile 3, $F(1, 27)$

= 12.068, p = .002; and quartile 4, $F(1, 27)$ = 9.112, p = .005. Figures 5 and 6 illustrate a greater positive effect of the treatment on students' test performance in quartiles 1 and 4 than the control. These differences are further illustrated by between subjects analysis where there are statistically significant differences between the treatment and control groups for quartile 3, $F(1, 27)$ = 8.078, p = .008, and quartile 4, $F(1, 27)$ = 13.400, p = .001 (Table 13). A medium effect size exists for quartile 3, ω^2 = .134, and a large effect size for quartile 4, ω^2 = .164. Post-hoc one-way ANOVA results identify no statistically significant difference between conditions at time 1, but there is a statistically significant difference between the treatment and control groups at time 2 for quartile 1, $F(1, 24)$ = 4.431, p = .046; quartile 3, $F(1, 28)$ = 13.697, p = .001; and quartile 4, $F(1, 28)$ = 12.609, p = .001 (Table 14). Findings revealed a medium effect of the treatment on student post-test performance for quartile 1, ω^2= .125, and a large effect size for quartile 3, ω^2= .312, and quartile 4, ω^2= .293.

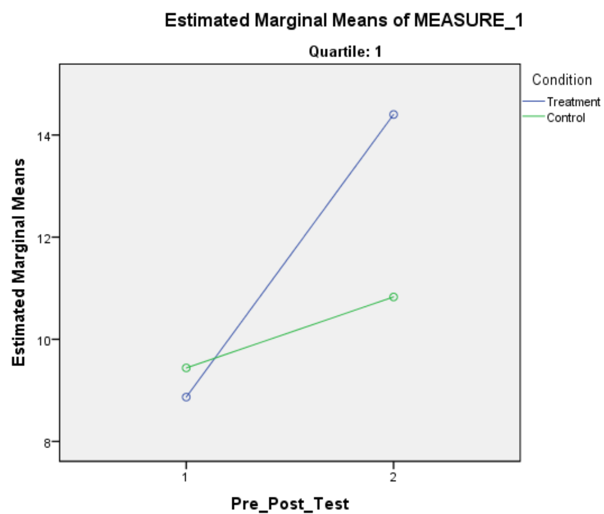

Figure 4 *Plot of quartile 1 pre- and post-test means for treatment and control groups.*

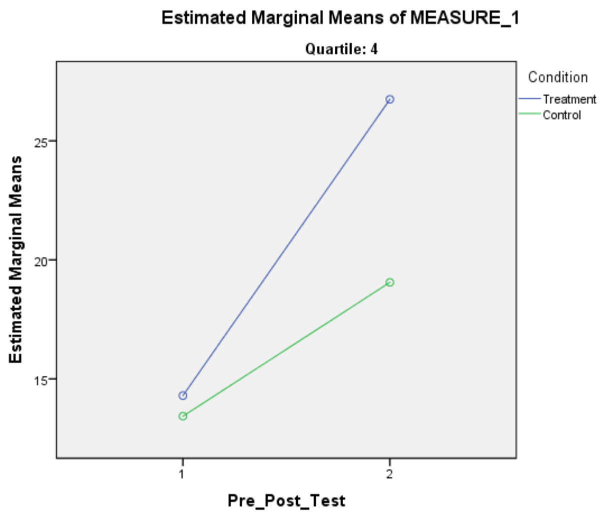

Figure 5 *Plot of quartile 4 pre- and post-test means treatment and control groups.*

There is also a statistically significant interaction between treatment and time for students initially recommended for both honors chemistry, $F(1, 82) = 15.421$, $p < .001$, and basic chemistry, $F(1, 29) = 5.386$, $p = .028$ (Table 12). Between subjects analysis shows a statistically significant difference, $F(1, 82) = 27.740$, $p < .001$, and a medium effect size, $\omega^2 = .121$, in test performance between treatment and control students who were initially recommended for honors chemistry. Post-hoc one-way ANOVA results identify no statistically significant difference between conditions at time 1, but there is a statistically significant difference between the treatment and control groups at time 2 for students initially recommended for basic chemistry, $F(1, 30) = 7.439$, $p = .011$, and initially recommended for honors chemistry, $F(1, 82) = 17.665$, $p < .001$ (Table 14). Findings revealed a large effect size for students initially recommended for basic science, $\omega^2 = .177$, and students initially recommended for honors science, $\omega^2 = .169$.

When disaggregated by race, findings show a statistically significant effect of time on Caucasian $F(1, 29) = 4.874$, $p = .035$, and Hispanic, $F(1, 14) = 3.787$, $p = .072$, student test performance (Table 12). There is also a statistically significant positive interaction between treatment and time for African American, $F(1, 33) = 4.096$, $p = .048$, Hispanic, $F(1, 14) = 8.791$, $p = .010$, and Asian, F (1,22) = 9.274, $p = .005$, students (Table 12). Between subjects analysis shows a statistically significant positive effect of the treatment on students' test performance for both African American, $F(1, 33) = 14.038$, $p = .001$, $\omega^2 = .183$ and Caucasian students, $F(1, 29) = 6.360$, $p = .017$, $\omega^2 = .102$ compared to students in the control group (Table 13). Findings show that the heterogeneous classes have the greatest magnitude of effect on African American students than all other subgroups with a large effect size of $\omega^2 = .183$.

Table 12 *Split-Plot ANOVA of pre- and post-chemistry test for within subjects by condition.*

	Time				Condition			
	df	*Error df*	*F*	*p*	*df*	*Error df*	*F*	*p*
Full Sample	1	113	12.626	.001	1	113	21.370	<.001
Quartile 1	1	23	.078	.783	1	23	4.534	.044
Quartile 2	1	27	.833	.370	1	27	0.369	.549
Quartile 3	1	27	.403	.531	1	27	12.068	.002
Quartile 4	1	27	.467	.500	1	27	9.112	.005
Recommended Basic	1	29	1.259	.271	1	29	5.386	.028
Recommended Honors	1	82	5.072	.027	1	82	15.421	<.001
African American	1	33	2.196	.148	1	33	4.096	.048
Caucasian	1	29	4.874	.035	1	29	2.032	.166
Hispanic	1	14	3.787	.072	1	14	8.791	.010
Asian	1	26	1.922	.177	1	26	9.274	.005

Table 13 *Split-Plot ANOVA and effect size of pre- and post-chemistry test for between subjects by condition.*

	df	*Error df*	*F*	*p*	*Effect Size (ω^2)*
Full Sample	1	113	23.136	<.001	.094
Quartile 1	1	23	2.019	.169	-
Quartile 2	1	27	0.753	.102	-
Quartile 3	1	27	8.078	.008	.130
Quartile 4	1	27	13.400	.001	.164
Recommended Basic	1	29	3.390	.076	-
Recommended Honors	1	82	27.740	<.001	.121
Black	1	33	14.038	.001	.183
White	1	29	6.360	.017	.102
Hispanic	1	14	2.330	.149	-
Asian	1	26	3.647	.067	.042

Table 14 *One-Way ANOVA and effect size of pre- and post-chemistry test scores between conditions.*

	Pre-Test				Post-Test				
	df	*Error df*	*F*	*p*	*df*	*Error df*	*F*	*p*	*Effect Size (ω^2)*
Full Sample	1	114	.733	.394	1	114	18.470	<.001	.133
Quartile 1	1	24	.300	.589	1	24	4.431	.046	.125
Quartile 2	1	28	2.625	.116	1	28	1.660	.208	-
Quartile 3	1	28	.395	.535	1	28	13.697	.001	.312
Quartile 4	1	28	.172	.682	1	28	12.609	.001	.293
Recommended Basic	1	30	.133	.718	1	30	7.439	.011	.177
Recommended Honors	1	82	1.906	.171	1	82	17.665	<.001	.169

Student Self-Efficacy Analysis

A t-test of independent means was used to examine the differences between student self-efficacy results by condition. Effect size was calculated using Cohen's (1988) formula: $(M_2 – M_1)/SD_{pooled}$ where $SD_{pooled} = \sqrt{((SD12 + SD22)/2)}$. Cohen (1988) suggests that effect size interpretations follow magnitudes as small (*d* = 0.2), medium (*d* = 0.5), and large (*d* = 0.8). For the full sample, findings revealed there are statistically different mean values for students in the treatment group (M = 5.305, SD = .842) compared to students in the control group (M = 4.904, SD = 1.132), $t(103) = 2.063$, $p = .042$ (Table 15). There is a small effect size of *d* = .402 between conditions for the full sample. There is no statistically significant difference between groups when disaggregated by quartile.

Table 15 *T-test of independent samples for student self-efficacy.*

		N	*M*	*SD*	*t*	*p*	*d*
Full	Treatment	53	5.305	.842	2.063	.042	.402
	Control	52	4.904	1.132			
Quartile 1	Treatment	11	4.893	.82102	1.845	.079	-
	Control	13	4.098	1.210			
Quartile 2	Treatment	12	5.296	.879	.026	.979	-
	Control	14	5.286	1.004			
Quartile 3	Treatment	15	5.503	.692	1.699	.101	-
	Control	13	4.986	.916			
Quartile 4	Treatment	15	5.418	.939	.453	.654	-
	Control	12	5.242	1.076			

Student Engagement Analysis

A t-test of independent means was used to examine the differences between student engagement results by condition. Effect size was calculated using Cohen's *d*. Student engagement survey results indicate there are statistically significant differences in mean values for the control group (M = 1.678, SD = .306) in comparison to the treatment group for the full sample, (M = 1.479, SD = .262), $t(106) = -3.613$, $p = <.001$; quartile 3, $t(26) = -2.967$, $p = .006$ ($M_{control} = 1.700$, $M_{treatment} = 1.408$), and quartile 4, $t(27) = -1.834$, $p = .018$ ($M_{control} = 1.614$, $M_{treatment} = 1.419$) (Table 16). A medium effect size exist between conditions in the full sample, *d* = .699, and quartile 4, *d* = .679. A large effect size exist between conditions in quartile 3, *d* = 1.13.

Table 16 *T-test of independent samples for student engagement.*

		N	*M*	*SD*	*t*	*p*	*d*
Full	Treatment	52	1.479	.262	-3.613	<.001	.699
	Control	56	1.678	.306			
Quartile 1	Treatment	12	1.552	.204	-2.032	.054	-
	Control	13	1.756	.286			
Quartile 2	Treatment	11	1.569	.327	-.590	.560	-
	Control	15	1.650	.356			
Quartile 3	Treatment	14	1.408	.231	-2.967	.006	1.13
	Control	14	1.700	.283			
Quartile 4	Treatment	15	1.419	.268	-1.834	.018	.679
	Control	14	1.614	.305			

Student Interest Analysis

Descriptive statistics.

The findings from the student interest in science survey show an increase in mean scores from pre- (M = 3.250) and post- (M = 3.620) responses from students in the full sample treatment group (Table 17). Similarly, results show an increase in mean scores from pre- (M = 3.23) and post- (M = 3.889) responses for students in the full sample control group. A similar trend is found when survey results are disaggregated by quartile with the exception of the treatment group in quartile one (Table 17). Survey results for this group show a decrease in mean scores from pre- (M = 3.822) and post- (M = 3.711) responses.

Table 17 *Descriptive statistics of a pre- and post-survey of student interest in science.*

		Pre-Survey			Post-Survey		
		M	*SD*	*N*	*M*	*SD*	*N*
Full	Treatment	3.250	1.217	46	3.620	.713	46
	Control	3.231	1.293	45	3.889	.796	45
Quartile 1	Treatment	3.822	1.464	9	3.711	.660	9
	Control	3.957	1.304	7	4.057	.632	7
Quartile 2	Treatment	3.390	1.473	10	3.850	.996	10
	Control	3.639	.928	13	3.954	.893	13
Quartile 3	Treatment	3.023	.956	13	3.462	.766	13
	Control	3.079	1.278	14	3.900	.744	14
Quartile 4	Treatment	2.993	1.050	14	3.543	.554	14
	Control	2.481	1.395	11	3.691	.869	11
Recommended Basic	Treatment	4.044	1.275	9	3.956	.831	9
	Control	4.000	1.048	11	4.327	.674	11
Recommended Honors	Treatment	3.067	1.139	37	3.538	.668	37
	Control	2.982	1.278	34	3.747	.788	34

Analysis of variance.

Prior to conducting statistical analysis, the student interest in science survey data was examined for homogeneity of variance and normality. Findings show that skewness and kurtosis values were well within acceptable limits (Trochim & Donnelly, 2006) (Table 18). Levene's test of equal variances shows a violation of homogeneity for pre-survey responses, $F(1, 89) = .004$, $p = .947$, and post-survey responses, $F(1, 89) = 1.152$, $p = .286$; however, sample sizes are equal so the effect of heterogeneity of variance on type 1 error is minimized (Lix, Keselman, & Keselman, 1996). Box M was found to be non-significant for the student interest survey data ($p = .581$) supporting the assumption of equal covariance.

The Split-Plot ANOVA results of student interest in science survey data examined 1) differences between treatment and control groups, 2) pre- and post-differences, and 3) the interaction between the two for the full and disaggregated sample at the quartile and initial student recommendation levels. The findings revealed a significant effect of time on student interest for the full sample, $F(1, 89) = 18.215$, $p < .001$; at the quartile level for quartile 2, $F(1, 21) = 6.173$, $p = .021$; quartile 3, $F(1, 25) = 7.579$, $p = .011$; quartile 4, $F(1, 23) = 11.500$, $p = .003$; and for students initially recommended for honors chemistry, $F(1, 69) = 20.811$, $p < .001$ (Table 19). Findings show there is no statistically significant interaction between treatment and time (Table 19). Between subjects analysis show no significant effect between treatment and control groups (Table 20).

Table 18 *Skewness and kurtosis for pre- and post-interest in science survey*

	N	*M*	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Pre-Survey	97	3.246	.156	.245	.010	.485
Post-Survey	106	3.823	.187	.235	-.721	.465

Table 19 *Split-Plot ANOVA for pre- and post-survey on student interest in science for within subjects by condition.*

	Time				Condition			
	df	*Error df*	*F*	*p*	*df*	*Error df*	*F*	*p*
Full Sample	1	89	18.215	<.001	1	89	.945	.234
Quartile 1	1	14	0	.986	1	14	.111	.744
Quartile 2	1	21	6.173	.021	1	21	.059	.648
Quartile 3	1	25	7.579	.011	1	25	.700	.411
Quartile 4	1	23	11.500	.003	1	23	1.614	.217
Recommended Basic	1	18	.228	.639	1	18	.695	.415
Recommended Honors	1	69	20.811	<.001	1	69	1.079	.303

Table 20 *Split-Plot ANOVA for pre- and post-survey on student interest in science for between subjects by condition.*

	df	*Error df*	*F*	*p*
Full Sample	1	89	.480	.490
Quartile 1	1	14	.288	.600
Quartile 2	1	21	.173	.682
Quartile 3	1	25	.745	.396
Quartile 4	1	23	.355	.557
Recommended Basic	1	18	.208	.654
Recommended Honors	1	69	1.079	.303

Classroom Observation Analysis

Score means and ranges from 12 classroom observations conducted by two observers using the Reformed Teaching Observation Protocol (RTOP) are presented in Table 21. Six observations of the treatment group and six observations of the control group (split between three basic and three honors level courses) were performed during the six-month study. The RTOP protocol disaggregates scores into five sections: lesson design, propositional knowledge, procedural knowledge, student-student interaction, and student-teacher interaction. When examining the descriptive statistics, the findings revealed that composite means for the treatment ($M = 71.3$) and honors level control group ($M = 79.7$) were greater than the basic level control group mean ($M = 25.3$) (Table 21). This trend also exists for each of the five RTOP sections. A one-way ANOVA Tukey HSD test was used to statistically examine differences between RTOP composite scores for the treatment and control conditions (Table 22). The control conditions were disaggregated into honors and basic science classes to further examine the differences between conditions. Findings revealed that the treatment group is not significantly different than the honors level control group ($p = .599$); however, there is a statistically significant difference between the treatment and basic level control group ($p = .001$). There is also a statistically significant difference between the honors level and basic level control groups ($p = .001$).

Table 21 *Reformed Teaching Observation Protocol (RTOP)[36] descriptive statistics.*

	N		*a*	*b*	*c*	*d*	*e*	*Total*
Treatment	6	*M*	10.7	16.7	14.2	12.0	17.8	71.3
		Range	7-17	15-19	10-18	6-16	13-20	56-89
Control Honors	3	*M*	14.5	17.5	17.1	15.5	18.0	82.5
		Range	11-18	17-19	16-18	13-18	17-19	76-89
Control Basic	3	*M*	2.6	4.7	4.3	4.0	9.7	25.3
		Range	0-5	2-7	3-7	0-8	6-14	11-37

Table 22 *One-Way ANOVA Tukey HSD analysis of RTOP scores.*

		Mean Difference	Std. Error	*p*
Treatment	Control Honors	-8.333	8.382	.599
	Control Basic	46.00	8.382	.001
Control Honors	Treatment	8.333	8.382	.599
	Control Basic	54.33	9.679	.001
Control Basic	Treatment	-46.00	8.382	.001
	Control Honors	-54.33	9.679	.001

[36] RTOP's five categories: a= lesson design; b=propositional knowledge; c=procedural knowledge; d=student-student interaction; e=student-teacher interaction

Teacher Survey Analysis

Self-efficacy.

Treatment teachers completed a pre- and post-survey measuring their confidence in their ability to support student self-efficacy. Each of the 19 survey items was rated from 1 (very little confidence) to 7 (very high confidence). Both treatment teachers showed an increase in confidence and treatment teacher A showed a greater increase in confidence (from M = 5.8 to M = 6.8) than teacher B (from M = 5.4 to M = 5.7) (Table 23). Overall, both teachers indicated a high degree of confidence in supporting student self-efficacy.

Table 23 *Survey results for treatment teachers' confidence in supporting student self-efficacy.*

Teacher	Mean Pre-Survey	Mean Post-Survey
A	5.8	6.8
B	5.4	5.7

Differentiated Instruction.

Treatment teachers completed a pre- and post-survey measuring their sense of efficacy for differentiated instruction. Each of the 14 questions was rated from 1 (low efficacy) to 9 (high efficacy). Treatment teacher A showed an increase in sense of efficacy for differentiated instruction over the course of the study (from M = 6.9 to M = 7.9) while teacher B showed a decrease in efficacy (from M = 7.4 to M = 6.0) (Table 24).

Table 24 *Survey results for treatment teachers' sense of efficacy for differentiated instruction.*

Teacher	Mean Pre-Survey	Mean Post-Survey
A	6.9	7.9
B	7.4	6.0

Mindset.

Treatment teachers completed a pre- and post-survey measuring their level of growth-mindset. Teachers rated their level of agreement with 16 statements. Eight statements in the survey demonstrated a growth mindset and eight statements demonstrated a fixed-mindset. Treatment teacher A showed an increase in growth-mindset over the course of the study (Table 25). On the pre-survey, teacher A positively responded to 4 of 8 fixed-mindset statements and 4 of 8 growth-mindset statements. On the post-survey, teacher A did not respond positively to fixed-mindset statements and did respond positively to all growth-mindset statements. Teacher B responded positively to all growth-mindset statements in both the pre- and post-survey.

Table 25 *Teacher survey results for mindset.*

Teacher	Pre-Survey		Post-Survey	
	Fixed-Mindset	**Growth-Mindset**	**Fixed-Mindset**	**Growth-Mindset**
A	4	4	0	8
B	0	8	0	8

Daily Strategy Form.

Both teachers of the treatment group returned electronic copies of the *Daily Strategy Forms* after each week of the intervention. The teachers most frequently posted (95%) the lesson’s chemistry goals including skill development goals (Table 26). The first three goal strategies were implemented over 80% of the time. The teachers were least successful at checking students’ calendars as a goal strategy. Feedback was provided to students during 86% of the classes while feedback to individual students occurred 62% of the time. Models were used on 38% of the days of the study.

Table 26 *Teacher responses on the Daily Strategy Form.*

Strategy	Percentage of Classes Implemented	Selected Teacher Comments
Goals		
1. Started lesson with a review of previous day's accomplishments	91	Mastery warm-up; Review of previous day as it relates to the day's lesson
2. Posted today's chemistry goals (skills)	95	Verbalized and wrote lesson agenda and objective; Explained why we were learning the skill.
3. Reviewed and checked goals (skills) achieved in today's lesson	81	Reviewed objective at end of lesson; Asked, "Did we met our goals?"
4. Allowed students time to write in their calendars	71	Students write in their journals on both content and reflections
5. Reviewed at least two students' calendars with them	24	Calendars are reviewed weekly and comments given
Feedback		
6. Complimented the class at least four times during the lesson on the skills it had mastered	86	Typically do this after each assessment
7. Privately complimented at least five students (verbally or on their papers) on how good they were at a skill	62	Graded quizzes, Journal entries
Models		
8. Early in a lesson had at least one student successfully demonstrated a measurement technique to the class	38	Students were randomly called upon to answer questions. Students helped each other

Student instructional aides.

Student instructional aides logged a total of 1,875 interactions with treatment students over the course of the study (Table 27). In their logs, student instructional aides indicated the type of support provided to students: math concepts and/or computation; content including vocabulary; organization including notebooks and/or course materials; and directions and/or processes. The greatest number of interactions (616 interactions) included support for math concepts and/or computation followed by directions and/or processes (449 interactions). The least amount of support was provided with course content (389 interactions).

Table 27 *Number of student instructional aide interactions with treatment students.*

	Math Concepts/ Computation	Content	Organization	Directions/ Processes
Number of Interactions	616	389	421	449

Dosage of intervention.

The treatment teachers formally met for an hour once per week for a total of 16 meetings over the course of the study. The researcher attended eight of these meetings. The teachers shared in their interviews that they often met up to four times a week at various times throughout the day to "touch base" on what is happening in class and how the students were performing. While the agenda of the formal meetings varied based on curricular and student needs, the treatment teachers spent approximately half of the meeting time discussing and designing lesson plans that incorporated student-centered and differentiated learning activities. They also spent time in the meetings reviewing student performance data and adjusting lesson and unit plans to support their students. Often, they discussed individual students and strategized on how to help support those students in terms of instruction and additional support in class. In addition, they occasionally discussed how their student aides could assist in delivering feedback and instructional support throughout their lessons.

Qualitative Results

Teacher Interview Data

Data was collected during meetings held with the chemistry teachers of the heterogeneous classes throughout the study. A one-hour interview was held with the treatment teachers at the conclusion of the study. The data is represented in themes created by the researcher and indicates that the teachers conscientiously worked toward implementing the professional development on student self-efficacy, mindset, and differentiated instruction. The teachers shared that all students began to believe in their ability to perform well in the class and “rose” to the teacher’s high expectations. The teachers also shared that the academic diversity of the class has helped support student success in the class.

Focus on praise and feedback.

Teachers made a concerted effort to complement their students’ success and to provide timely feedback on student work. Teachers shared that they were specific in the type of praise used with students. One teacher said, “Praise is important and we complemented what students did correctly.” The other teacher said, “We provided immediate feedback to students about their work in class and we used the student aides to support this.” Teachers allowed students additional chances to submit quality work. One teacher said, “We allowed for second chances. I had to reintroduce this into my teaching practice. The whole point is mastery and not punishment. I asked students to fix their mistakes and resubmit their work until it is correct." In addition to individual praise and feedback, teachers shared that they praised the entire class when students did something well as a class.

Focus on beliefs.

A combination of high expectations, encouragement, and the diversity of student abilities helped increase students' sense of self-efficacy over time. One teacher said, "We are thoughtful of how students can be turned off if they feel that they can't be successful so we instilled in them a belief that they can be successful. We praise them when they show mastery of a skill or content and we encourage them when they do not." Both teachers shared that most students have developed a belief that they can be successful in the class and that they are "rising to meet our high expectations." One teacher said, "We are constantly encouraging students to ask questions and probe when they don't get the answer. We stick with the students. This has helped build their self-efficacy." Teachers shared that the diversity of academic ability in the class has helped support students' beliefs in their own ability to be successful in the class. One teacher reflected on a challenging lesson she taught toward the beginning of the school year:

> I handed out a challenging set of problems for students to work on individually. I noticed that some students began thinking about the problems right away. At the same time, other students were looking around the classroom at their peers. After a minute, those students who initially seemed intimidated by the problems began working on them. This happens all of the time. Students watch their peers engage in the lesson and they join them. They believe that they can do it because they see others doing it.

Focus on mastery and differentiated instruction.

A focus on student mastery and differentiated instruction has led to higher student achievement. One teacher said, “We are all about mastery; we work to build their skills to mastery.” The teachers supported student mastery by chunking and scaffolding course content and by implementing differentiated instructional strategies. One teacher said, “We found that scaffolding material is really important in the mixed ability group and that learning stations and compacting are great strategies to support scaffolding.” In addition, the teachers challenged their students to think critically about the course content. One teacher said, “We are using *challenge problems* to build their critical thinking skills and they are now taking risks to challenge themselves.” The teachers also use daily journaling to support students’ learning and reflection. The journals provide a space for students to reflect on their academic progress in the course and provide students with the opportunity to make connections between course content and their prior knowledge and experiences. The teachers review journals on a weekly basis and provide students with feedback by offering comments, questions, and praise.

The teachers also shared that students in the mixed ability classes support each other’s learning that elevates the level of everyone’s work. One teacher said:

> The class composition is very powerful. In the mixed ability you have some strong students that can really support struggling students and pull then up. You have lots of mini tutors. The stronger students end up understanding the material even better. We also used flexible grouping strategies where sometimes students with similar ability students and at other times they were grouped by interest or in mixed ability groups.

Goal Setting.

Teachers shared that clearly communicating objectives and goals helped students know what they need to do to be successful and to build their self-efficacy. One teacher said, “At the end of each day we looked at the lesson’s objectives and asked ourselves if we have achieved our goals for the day.” The teachers also provided students with a checklist of the lesson’s goals on the board. At the end of each class they reviewed the checklist and together say, “We got that” and then they move on. One teacher said, “If there are questions [about an item on the checklist] then I make a note on the board to revisit it during the next lesson.

Interest.

The teachers focused on making all classroom activities more meaningful. The teachers reflected on their use of journaling:

> We have a “curious page” in their journals where students record questions about anything related to chemistry. We use this as anchor activities and we respond to their questions in the journals. The teachers shared that students enjoy adding artifacts and real life experiences to their journals and see this activity as a way to increase student interest in chemistry.

Classroom management and student behavior.

The heterogeneous classes have significantly reduced classroom behavior and management problems. One teacher said, “I know there is fear from parents and teachers about moving on-level students to honors classes in terms of classroom behavior. We have had absolutely no behavior problems. Students are rising to the challenge.” The other teacher offered specific examples of how students are more engaged and less likely to present off-task behavior. She said, "The other neat thing is that there are no heads down. It is amazing. Everyone is listening. Sometimes you get the confused face but they are all trying to learn."

Student instructional support.

Student instructional aides provide essential support in heterogeneous classrooms. One teacher said, "Having the student instructional aides was phenomenal. They helped provide immediate feedback to students. They can check homework and in class assignments very quickly. They do it while we are working on the warm up or while I am busy helping students. There is no break in instruction with their support."

Student Interview Data

Data was collected during semi-structured, 30-minute interviews at the end of the study. Six students with different initial achievement levels, races, and gender were selected for interviews. Five main questions were asked of the students: (1) What has been your experience in chemistry this year; (2) What instructional strategies worked best for you; (3) How has your chemistry teacher praised you throughout the school year; (4) How much do you enjoy science; and (5) Do you see yourself pursuing a career in science?

What has been your experience in chemistry this year?

One of the initially lower achieving students shared that with effort he can be successful. He also discussed the importance of receiving attention and feedback from his teacher. He said:

> At first I thought it [the class] was hard. The elements were complicated. Overall it takes practice and studying. If you always practice and study you will get the

> subject. If you don't do the homework, which I have learned, it will tear you down. The homework will help you with the upcoming test. I understand what the teacher explains. Every now and then I get a little shaky and then she will explain to me. She is a really good teacher. She will explain one-on-one, which really helps me. She will slow down and explain it better if you ask. I feel comfortable asking questions in class. I just asked a question. Like, the linear concept of the bent. She explained it to me. If there are two double bonds on each side it can turn bent. It also matters if it is symmetrical or nonsymmetrical. I get that now.

Another initially lower achieving student shared that the class was difficult for her, but that she sees the benefits of effort and support. She said:

> It has been stressful. Chemistry is my least favorite class. There is a lot of math and science, which I don't like. I have to work really hard in class. I go in for lunch and study a lot and retake quizzes when I can. I am comfortable asking question in class. The student aides have been really helpful. They explain the information well and help me understand it.

A higher achieving student reflected on his experience in the class and said, "It's a class that you have to focus on. Everyone is focused. Everyone is cooperative. We work as a class, help each other out." Another higher achieving student said, "I had a good experience and she is a good teacher. She makes sure everyone knows what they are doing and she'll ask if everyone understands. If not, she will help. She will go to the individual. I am comfortable asking questions in class and she really explains everything clearly."

What instructional strategies work for you?

Students shared that their teachers' availability to answer questions and to provide one-on-one support is important for their success. They also shared that having to answer questions in class is an important way for them to learn the material. One student said:

> First she [the teacher] explains what she is teaching for the day. She asks us all a lot of questions. I've realized that it is best for me. I get nervous when called on, but it's best. She helps me understand. She is available for one-on-one, during lunch, and after school. She goes over my work. Why it's wrong and how to get to the answer. I have gotten more comfortable over time asking question.

One student reflected on how reviewing the objectives and checkpoints each day helped with her learning. She said, "She [the teacher] puts the big picture on the board then goes over step by step and asks questions at each step." Another student shared that the group work helped her learn in class. He said, "I can ask my peers and they can explain it better. When we do labs together and check homework together. Station activities work well to because I can ask peers questions." Another student shared that he found the homework to be very important to his learning:

> I would say mostly the homework because sometimes we get problems that we haven't reviewed in class. Then we come in and review the homework. When I do the homework I like to understand what I am doing and my mind can go blank. I try to practice on homework and now when I get a hard problem I try my best. Homework has gotten easier over time. Paying more attention and doing more homework and asking more questions help a lot.

How has your chemistry teacher praised you throughout the year?

The use of humor and calling on practices made one student feel comfortable in class. The student said, "She [the teacher] makes a joke with the work, *Ammonia going to tell you this once!* It makes it fun. Calls on students that do not understand to get their confidence up. If I'm doing it right, she uses her finger to point and explain that I'm doing it right. If I don't get it right, she points to it and says, *This is wrong because….* She explains why it is wrong on the spot." Another student felt that one-on-one feedback was important to her. She said, "If I get a good grade she will come up to my desk and tell me that I did a good job." Another student shared that his teacher would praise the entire class when they did something well. He said, "She will tell the whole class if a lot of people did a good job." Another student shared that his teacher paid close attention to his skill development. He said, "Skill wise, she will say, *Good job doing that, you understand how to do that."*

How much do you enjoy science?

Do you see yourself pursuing a career in science? One initially lower achieving student shared that he is now interested in pursuing a career in science. He said, "My first plan was to become a realtor or business, but now I'm thinking about science of any type. I think I'd like environmental science the most. That area. I definitely will be going to college. I'll be taking honors physics next year." Another initially lower achieving student said, "I am enjoying the class. I do see myself science now. I want to study physical therapy. This class has helped me believe in my own ability. When I put the effort in I can do it. I'm thinking of going to Buffalo University and I'll be taking AP psychology next year." An initially higher achieving student shared that she has always enjoyed science and that "Chemistry is my favorite subject and I want to possibly pursue a career in science; I'm thinking maybe molecular biotech, a possible researcher, and get my doctorate." One student shared that she is more focused on music and performing arts. She said, "My passion is music and performing arts and I am involved in theater and outside of school; I am not interested in science, but I will be taking AP environmental science next school."

Analysis and Discussion

African American are often placed into lower-level secondary courses where they receive an inequitable opportunity to learn compared to their peers in higher-level courses (Gamoran, 1987; Hallinan, 1988; Oakes, 2005; Mayer, 2008). Students enrolled in lower-level courses are often precluded from pursuing post-secondary degrees in STEM because high-level coursework in science and mathematics leads to post-secondary enrollment and degree attainment (Adelman, 2006; Bonous-Hammarh, 2000; Maple & Stage, 1991; Tyson et al., 2007). In response to the problems associated with ability grouping, researchers have begun to study the effect of detracking strategies on student achievement and other non-cognitive factors such as student interest, engagement, and self-efficacy (Alvarez & Mehan, 2006; Burris, 2014; Nomi & Allensworth, 2014; Rui, 2006; Yonezawa & Jones, 2006). The needs assessment conducted in this study identified that African American students are disproportionately placed into lower-level science classes and their placement in these courses was based on recommendations made by their teachers by using a variety of data including subjective, non-meritocratic factors such as perceived student motivation and work ethic. Teachers' use of subjective factors during the course recommendation process may allow for their biases and perceptions of student ability to influence their recommendations (Aschbacher et al., 2010; Campbell, 2010; Fancis, 2012; Oakes, 2005). The purpose of this study was to investigate the possible negative effects of ability grouping in a high school by creating heterogeneous secondary school science classes with the intent to increase overall student achievement and subsequent access to the STEM pipeline.

This study finds that students in heterogeneous chemistry classes outperform their peers in traditional homogeneously grouped classes with an effect size of $\omega^2 = .094$. Higher effect sizes are identified for initially higher achieving students in quartiles 3 ($\omega^2 = .130$) and 4 ($\omega^2 = .164$) and students who were initially recommended for honors ($\omega^2 = .121$). These results are significant in that previous studies typically find there is little to no effect of heterogeneous classes on high achieving students (Rui, 2009). This study finds that heterogeneous classes have the greatest positive effect on high achieving students; however, there is a significant positive interaction between treatment and time for initially lower achieving students suggesting that heterogeneous classes also provide positive outcomes for these students. These results are consistent with previous studies showing that heterogeneous classes have a positive effect on lower achieving students (Burris, Heubert, and Levin, 2006; Rui, 2009).

When the study sample is disaggregated by race, results show the greatest effect size for African American students in the heterogeneous classes ($\omega^2=.183$) when compared to all other subgroups. These results are consistent with previous studies showing heterogeneous classes increase student academic performance (Burris, Heubert, and Levin, 2006; Burris, 2014; Watanabe et al., 2007). Other studies have identified that high expectations of African American students lead to higher academic achievement (Ware, 2006). Teachers of the heterogeneous classes share that they hold students in their heterogeneous classes to the same level of expectations as they hold their honors level students. Likewise, students in the heterogeneous classes share that their teachers hold them to high standards and provide them with the support they need to be successful. These results suggest that the combination of the heterogeneous class, high expectations, and support results in significant positive outcomes on African American academic achievement.

This study finds that students in the heterogeneous classes have a greater degree of self-efficacy for learning chemistry than their peers in the control sample. These results support previous studies that identify self-efficacy as an important factor in student achievement (Siegle, 1995; Zimmerman, Bandura, & Martinez-Pons, 1992). Other studies have found that students in higher-ability classes have a greater degree of academic and personal self-concept and self-efficacy than students in lower-ability classes (George, 1993; Hall, 2014; Rui, 2006). This study revealed that initially lower and higher achieving students in the heterogeneous classes have a greater degree of self-efficacy than their peers in traditional homogeneous groups. An important factor associated with the greater level of self-efficacy in the heterogeneous classes is that the teachers were focused on increasing students' belief in their ability to be successful chemistry students. It is evident from the teacher interviews, classroom observations, and student interviews that the teachers of the heterogeneous classes implemented strategies to build student self-efficacy. These strategies largely included the teachers' use of praise and encouragement.

Students' self-reported engagement levels were greater for students in the control group for the full sample and in quartiles 3 and 4. These results contradict the assumption that student engagement is an important factor in student achievement. However, results from classroom observations indicate there is no difference in RTOP scores between teaching practices in the heterogeneous and control group honors level classes. These results suggest that the treatment and honors level control group teachers are implementing similar student-centered lessons that engage students in discourse and critical thinking. Further, there is a significant difference in RTOP scores between instruction in the heterogeneous and basic level control group. RTOP scores are greater for the heterogeneous classes suggesting that the teachers of the heterogeneous classes are implementing more student-centered lessons that engage students in critical thinking and discourse than teachers of the basic level science classes. It can be concluded from this data that students in the heterogeneous classes who were initially recommended for basic science received equitable opportunities to learn compared to their peers in honors level courses. Further, initially higher achieving students in the heterogeneous classes received the same high-level instruction as their peers in honors level courses. The contradictory results between student engagement survey responses and RTOP scores are puzzling because it was assumed that high-level instruction in the heterogeneous classes would increase student engagement. As such, student engagement in heterogeneous classes requires further investigation.

Students who have an interest in STEM are much more likely to pursue post-secondary degrees and careers in STEM (Maltese & Tai, 2011; May & Chubin, 2003). Findings from this study revealed that students' interest in chemistry in both the treatment and control conditions increased over the time of the study. There are no significant differences between students in the heterogeneous classes and students in the control group. These results suggest that chemistry classes, independent of the enrolled class, positively influenced students' interest in science. However, when disaggregated by quartile, there is no significant effect of time on student interest for students in quartile 1 identifying that initially lower achieving students had no change in their level of interest in science. These results are concerning as interest in science is a strong predictor of student retention in STEM pathways (Maltese & Tai, 2011, Moore, 2006; Tyson et al., 2007). Perhaps students in the heterogeneous classes will find additional interest in science as they continue to find success and encouragement in science classes. It would be interesting to study how their interest in science may change over a longer period of time. In addition, further investigation is required to determine the factors associated with student interest in science for those who demonstrate lower achievement levels.

Teacher survey data suggests that professional development on mindset positively influenced teachers' degree of growth mindset and decreased the degree of their fixed-mindset. These results are consistent with previous studies that show how professional development on mindset creates a stronger sense of teacher growth-mindset (Dweck, 2006). Likewise, professional development on student self-efficacy increased teachers' confidence in supporting student self-efficacy. These results are consistent with Siegle's (1995) findings. Interestingly, professional development and experience in heterogeneous classes show mixed results for teachers' sense of efficacy for differentiated instruction. One of the treatment teachers indicated an increase in confidence while the second teacher indicated a decrease in confidence. During the teacher interviews, teacher B shared that differentiating instruction was more difficult in the heterogeneous classes than in her high-level homogeneous classes. She felt that her decrease in confidence is likely a result of her sense of challenge in teaching the heterogeneous classes. These results suggest that teachers of heterogeneous classes should be aware that their confidence in teaching these classes may be challenged. It would be interesting to measure the change in the teachers' confidence over a longer period of time. Her confidence may increase over time as she becomes more comfortable and skilled in teaching heterogeneous classes.

Teachers identified student instructional aides as an essential component to student success in the heterogeneous class. This data is consistent with previous studies showing that support for initially lower achieving students in heterogeneous classes supports student success (Alvarez, 2006; Rubin & Noguera, 2004; Watanabe, 2007). Chemistry course content requires students to apply a significant amount of mathematical concepts and the instructional aides indicated in their interaction logs that most of their support to students was with math concepts and computations. Students in the heterogeneous classes shared that the student instructional aides support their learning by helping explain course content and by providing immediate feedback.

Implications

There are multiple stakeholders that act as key players in the development and implementation of detracking interventions. Andreasen and Kotler (2007) describe three fundamental challenges that school leaders face when attempting to implement an intervention: (1) who should be their target audience, (2) what are the behaviors they want to change, and (3) what are the value propositions they should propose to secure those ideal behaviors. As such, it is important for school leaders to consider outcome behaviors and the actions required to meet those outcomes when planning for a detracking intervention. A focus on changing stakeholders' behavior is essential because "nonprofit marketing objectives always involve influencing the behavior of target audiences, and target audiences always have something else they can do including doing nothing" (Andreasen & Kotler, 2007, p. 158). Tables 28 and 29 present a list of internal and external stakeholders, behavior outcomes, and value propositions that should be considered as school leaders plan for implementing a detracking strategy. The implications of this study for teachers, school-based administrators, district leaders, and policymakers are also discussed in this section.

Table 28 *Internal stakeholders, behavior outcomes, and value propositions.*

Stakeholder	**Behavior Outcomes and Value Propositions**
School Administrators	A change toward creating heterogeneous classes requires a shift in school culture, staff's beliefs, and district policy requiring substantial professional development. The principal and administrative team need to be prepared to lead this change.
Teachers and Counselors	Professional development is required to change staff's beliefs about student ability and intelligence. Resistance to a change in school structures and processes must be addressed. Counselors advise students during the course recommendation process, coordinate parent-teacher conferences, coordinate the college application process, and are typically the first contact from parents when there are problems with their children at school. As such, counselors will need to fully support detracking reform and promote its tenants to students, parents, and teachers.
District Leaders	Support from district leaders is required to expand detracking interventions within schools and across districts as they are the first line of contact from parents and community members at the district level. They are essential stakeholders in scaling detracking interventions in regards to working with schools on implementation and confronting oppositional resistance from parent organizations, boards of education, local government officials, and influential community members.
Students	Some students will resist a change in school course placement structures and processes. High achieving students may believe that heterogeneous classes will negatively affect the rigor and challenge of their instruction and curriculum. They may also believe that there will be increase in behavior problems associated with heterogeneous classes. These beliefs need to be addressed through support and encouragement from school leadership and staff.

Table 29 *External stakeholders, behavior outcomes, and value propositions.*

Stakeholder	Behavior Outcomes and Value Propositions
Parents and Community Organizations	Many parents (of both low and high achieving students) and community organizations that support the school will resist a change in school structures and processes due to institutional expectations and norms (Meyer & Rowan, 2006). Their beliefs and perceptions about student ability and intelligence will need to be addressed. In addition, parents of underrepresented students in high-level course work may not understand the negative impact that ability grouping and tracking has on their children. Information regarding the impact of ability grouping will need to be shared with parents along with the benefits to detracking reform. Parent groups such as parent-teacher-student-associations should also be mobilized to support institutional change (Ishimaru, 2014; Warren & Mapp, 2011).
Science Organizations and Businesses	Gaining support from local and national science organizations and businesses can help support the expansion of detracking interventions by increasing its credibility and legitimacy within the community.
State Department of Education and Local Politicians	Support from government agencies such as the county councils can help legitimize the implementation of detracking interventions as an important institutional process. It is critical for schools to communicate the needs of the institution to government officials so that they are supported by both fiscal and non-fiscal policies and politics (Brumfield & Miller, 2008).
Media	The media can be used to communicate the school's goals and plans for implementing the intervention and to share its successes. Examples include local media such as town newspapers and also well regarded publications such as Ed Week and administrators' union newsletters. Schools that strategically engage the media in their vision and brand are more successful in their marketing efforts (Peyronel, 2004).
Colleges and Universities	Support from admissions officers will help communicate admissions criteria and that heterogeneous classes do not impair students' chances of admission to parents and students (Welner & Oakes, 2000).

Teachers.

Teachers of heterogeneous classes need to believe that all students can be successful in high-level courses. The treatment teachers in this study believe in the potential of all of their students and they relentlessly communicate these beliefs to students. They hold their students to high expectations, and at the same time, exude a high-level of caring and support to each student. While both of the treatment teachers in this study have a high-level of innate ability to motivate students and deliver engaging lessons, the professional development they received on building student-self efficacy, growth mindset, and differentiated instruction built on their prior knowledge and skills. Both teachers shared in interviews that the professional learning received throughout this study supported their ability to effectively deliver curriculum and instruction to an academically diverse set of students. Teachers who volunteer or who are asked to teach heterogeneous classes should have access to professional development that promotes growth mindset and provides concrete strategies to support student learning in heterogeneous classes.

School Administrators.

Many school administrators are considering interventions that will support the detracking of their schools. These administrators understand the negative effect ability grouping has on student access and opportunity, particularly for their students of color and lower-socioeconomic status students. Principals and other school-based leaders need to strategically plan for how their detracking strategy will be implemented. Figure 7 provides the study site's plan for full implementation of their detracking strategy. First, the plan detracks courses gradually over time by starting with a team of teachers who demonstrate a vested interest in supporting heterogeneous classes. This core group of educators should have the opportunity to analyze school data and share ideas and beliefs about mixed ability classes. In this study, the teachers of heterogeneous classes had the opportunity to share their beliefs about ability grouping and examine needs assessment data six months prior to teaching the classes. Later in the intervention, the group of teachers worked to produce and communicate the positive results administrators needed to convince reluctant stakeholders that detracking is best for all students. For example, in addition to the heterogeneous classes presented in this study, the school simultaneously created heterogeneous classes in English and social studies. The teachers of these classes all volunteered to participate in the intervention and to support the school leaderships' vision for detracking.

Key Stakeholders:	Teachers/Staff	Students	Parents/ Community	Administrators			

ACTIVITY	PLAN START	PLAN DURATION	Year 1	Year 2	Year 3	Year 4	Year 5
Teacher Inquiry Group	1	2					
Addressing Teacher Beliefs	1	2					
Professional Development on Instructional Strategies	2	4					
Adress Student Beliefs	2	4					
Policy Brief to District Administrators	1	1					
Parent Advisory Board	1	2					
Community Forums	2	4					
Media Outreach	2	2					
Training School Leaders & Hiring Practices	1	5					
Phase Out Lower-Level Courses	2	4					

Figure 7 *Project plan for the implementation of a detracking intervention.*

The intervention plan should also include ways in which student achievement and successes will be measured. Pre- and post-tests should be used to show growth in student achievement over time and students' achievement in heterogeneous classes should be compared to students' achievement levels in traditionally grouped classes. District and state assessments can provide a standardized instrument to collect this data. Most importantly, teachers of the heterogeneous classes need to share their experiences and stories with their colleagues and other stakeholders. If student instructional aides are used, their experiences should also be shared. Following this study, a video of student instructional aides was created and shared with staff regarding their positive experiences working in the heterogeneous classes. Teachers of the heterogeneous classes also shared their experiences with staff and answered questions from colleagues about teaching in heterogeneous classes.

Administrators should be prepared for oppositional resistance from multiple stakeholder groups including teachers, parents, department chairs, and district leaders. It is important for administrators to create and communicate a clear vision that describes their beliefs and expectations for the detracking intervention; however, administrators should be cautious with whom they are speaking to about the detracking plan. It is recommended that the plan remain relatively discreet until data is collected to support detracking in their school. At the site of this study, only teachers of the heterogeneous classes, district supervisors, and the parents of students initially recommended for basic science were informed of the detracking plan and vision. This minimized the amount of resistance received from stakeholders. After the study completed, larger groups of teachers and the school's Parent-Teacher-Student Association (PTSA) were presented with the vision, plan, and results from the pilot heterogeneous classes. After securing their support, over 40 additional heterogeneous class sections in science, English, social studies, and mathematics were created for the following school year.

District Leaders.

District leaders are beginning to understand the benefits to heterogeneous classes as they work to create district-wide initiatives to close academic achievement gaps. School administrators need district leaders' support as they implement their detracking strategy. Superintendents and other district leaders need to be prepared for oppositional resistance from parents, boards of education, and community members. District leaders should ensure they understand the vision and plan for detracking at each of their schools. Similar to school-based administrators, district leaders should be able to articulate a clear vision for detracking and speak to the benefits of how heterogeneous classes are best for all students. Most importantly, district leaders should work with schools to collect school-based data that can be used to support the district's vision for detracking. For example, school administrators at the study site met with their district supervisors once every two months to update them on the progress of the intervention by sharing student performance data. Further, district leaders should provide opportunities for parents and community members to share their beliefs about detracking in open forums. It is recommended that school-based leaders and teachers of heterogeneous classes attend these meetings to share their experiences about detracking.

Colleges and universities, science organizations, and local businesses can also be leveraged by district leaders to communicate support for detracking. Information from these groups can be shared through new delivery systems such as small group meetings with district administrators, breakfast with parents and community members, or lunchtime meetings with students, teachers, and administrators. New media outlets such as local newspapers and union newsletters could also be utilized. The support from these organizations will increase the legitimacy and credibility of the intervention. For example, administrators of the school studied in this report previously established a strong partnership with a local biotechnology company to help them communicate to school community members that more students need access to high-level science and mathematics courses. To support the school leadership's vision, the company also created internship, field trip, and in-school laboratory opportunities for students.

Policymakers.

In many districts, detracking may require a shift in policy set by boards of education. As such, board members and other elected town or county officials should develop a deep understanding of detracking interventions and work to leverage support for policy change. This study adds to the detracking literature by providing additional evidence that detracking is a school improvement strategy that increases achievement levels for all students and reduces academic achievement gaps. Policymakers can use data from this study to make data-based policy decisions as they consider how to meet the needs of an increasingly diverse nation of students.

Conclusion

This study informs the detracking literature by providing a successful detracking intervention that can be replicated by secondary school educators. This study shows that regardless of course recommendation, initial achievement level, and race, students in high-level heterogeneous science classes outperform their peers in traditionally grouped course levels. Students in these heterogeneous classes now have access to post-secondary STEM degree and career pathways. This is particularly important for African American who are underrepresented in college STEM programs.

It is important for educators who are detracking their schools to provide professional development to teachers in the areas of differentiated instruction, student self-efficacy, and mindset. Students of diverse achievement levels come to heterogeneous classrooms with a diverse set of needs that may create instructional challenges for teachers. As such, the implementation of differentiated instructional strategies is essential in supporting student learning in academically diverse classrooms. Further, all students benefit from their teachers' high expectations and this is particularly important for students of color. It is important that teachers in heterogeneous classes create a classroom climate of high expectations, praise, support, and encouragement to build students' confidence and belief in their own abilities to achieve in high-level classes. Teacher professional learning on mindset and praise should be offered to support them with strategies that work to increase their students' self-efficacy.

Finally, it is important to provide teachers in heterogeneous classes with student instructional aides. Students in heterogeneous classes have different instructional needs including pacing, scaffolding, and modes of content delivery. Student instructional aides provide teachers with first instruction support by providing a means to deliver immediate feedback to students about their work. In addition, student instructional aides provide students with one-on-one support for students who need additional assistance.

As school leaders consider how to detrack their schools they should plan to address possible political and social resistance from staff, parents, and students. Ability grouping is an institutionalized process that is widely supported by stakeholders. This study provides evidence that heterogeneous science classes produce positive outcomes for all students in science and should be used by educators to leverage stakeholder support and drive organizational change.

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Appendices

Appendix A

Teacher Survey on Recommendation Criteria and Beliefs About Ability Grouping

What factors do you take into consideration when you are making course recommendations for students? Check all that apply.

- student course grades
- student work ethic
- homework completion
- student behavior
- student attention/focus in class
- parental support
- student academic goals
- academic skills
- student interest in science
- student cultural/ethnic background
- other [open ended]

Please indicate the degree to which you agree or disagree with the following statements.

Strongly Disagree = SD
Disagree = D
Undecided = U
Agree = A

1. Science teachers play an important role in determining the science classes students enroll in.
2. Parents play an important role in determining the science classes students enroll in.
3. Students play an important role in determining the science classes they enroll in.
4. Students are allowed to choose the classes they would like to enroll in.
5. Science teachers communicate with other teachers in their department about issues related to student course placement.
6. Parents are aware students are tracked into science classes taught at different academic levels.
7. Students are aware they are being tracked into science classes taught at different academic levels.
8. Once a student is placed in a lower-level science class it is difficult to move into a higher-level track.
9. Students in low-track science classes are provided with information about enrolling in academically advanced classes (AP, honors, and on-level).
10. Students in low-track science classes are provided with adequate information to make informed decisions about enrolling in academically advanced classes (AP, honors, and on-level).
11. Parents of students in low-track classes voice their concerns about the impact of

tracking.
12. Parents of students in high-track classes voice their concerns about the impact of tracking.
13. The school has written policies for assigning students to classes.
14. The science department has written policies for assigning students to classes.
15. Science teachers use the same criteria when recommending students for classes.
16. Science teachers use similar criteria when recommending students for classes.
17. Criteria used by science teachers to recommend students for classes are determined at the department level.
18. Individual teachers determine criteria used to recommend students for classes.
19. Course placement recommendations should be based on academic criteria such as test scores and grades.
20. Teachers should consider non-academic criteria such as effort, attitude, or future aspirations when making course placement recommendations.
21. Course placement recommendations should be based on a combination of academic and non-academic factors.
22. Criteria used by science teachers to recommend students for classes should be decided by school administration.
23. Criteria used by science teachers to recommend students for classes should be decided at the department level.
24. Individual teachers should decide criteria used to recommend students for classes.
25. Slower learners would benefit more if placed in classrooms with students of higher ability.
26. Brighter students learn best when grouped with brighter students.
27. Academic tracking seems to separate students by social class.
28. Academic tracking seems to separate students by race.
29. Academic tracking has negative consequences for the future educational, employment or life chances of some students.
30. There is a better spirit of cooperation among students if they are tracked with students of similar ability.
31. I can often determine the track a student is in or will be assigned soon after I meet him/her.
32. Academic tracking enables teachers to provide top quality educational experiences education to all students.
33. Academic tracking enhances academic achievement of faster learners.
34. Academic tracking enhances academic achievement of slower learners.
35. Academic tracking enhances self-concept of faster learners.
36. Academic tracking enhances self-concept of slower learners.
37. In general, teachers in my school are supportive of academic tracking.
38. Academic tracking is helpful as a classroom management tool.
39. I prefer to teach higher ability groups.
40. Academic tracking perpetuates inequality in America.
41. A mixed ability class is just as easy to teach as a homogeneous class.
42. Please list any school policies or guidelines related to student course placement. Please explain.
43. Please list any science department policies or guidelines related to student course

placement. Please explain.

44. As things stand now, how far in school do you think your students will get?

	Less than HS Graduation	HS Graduation or GED only	Attend or complete 2 yr school course in community or vocational school	Attend a college but not complete a 4 year degree	Graduate from a 4 year college	Obtain a Masters degree or equivalent	Obtain a PhD, MD or other advanced degree
Low Performing Students							
Average performing students							
High performing students							

Appendix B

Informed Consent Form for Teacher Survey on Recommendation Criteria and Beliefs About Ability Grouping

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Informed Consent Form

Title: Detracking in Science
Principal Investigator: Dr. Carolyn Parker, Johns Hopkins University
Date: March 30, 2016

PURPOSE OF RESEARCH STUDY:
The purpose of this research study is to determine how students are placed into different course levels and whether they are placed appropriately. We anticipate that approximately 18 teachers will participate in the survey.

PROCEDURES:
1. You will complete an online survey.
2. You may be asked to participate in an interview with the researcher.

Time required: The survey will take approximately 20 minutes to complete. If selected, you will participate in an interview that will take 30 minutes outside of class time.

RISKS/DISCOMFORTS:
There are no anticipated risks to teachers.

BENEFITS:
Potential benefits are an increased understanding of how students are placed into different course levels. With this understanding, more effective course recommendation and placement processes may be created and implemented.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:
Your participation in this study is entirely voluntary. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled. If you want to withdraw from the study, or you want to stop participating, please contact Matthew Paushter, Assistant Principal at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org.

CONFIDENTIALITY:
Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for

making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

No identifiable information will be included in any reports of the research published. A participant number will be assigned to all surveys. Surveys will be collected in electronic format. Survey data completed electronically will be collected via a password protected Google Forms account. Data will not include identifiable information.

All research data including surveys and audiotapes from focus group interviews will be kept in a locked office. Electronic data will be stored on a private computer, which is password protected. Any original tapes or electronic files will be erased and paper documents shredded, ten years after collection.

Only group data will be included in publication; no individual data will ever be published.

COMPENSATION: You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS: You can ask questions about this research study at any time during the study by contacting Matthew Paushter in person, via phone, or email: (301)-601-4660, Matthew_K_Paushter@mcpsmd.org. You may also contact another researcher, Heather Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

SIGNATURES WHAT YOUR SIGNATURE MEANS: Your signature below means that you understand the information in this consent form. Your signature also means that you agree to participate in the study. By signing this consent form, you have not waived any legal rights you otherwise would have as a participant in a research study.

Teacher Name

Signature of Teacher Date

Signature of Person Obtaining Consent Date (Investigator or HIRB-Approved Designee) and Date

Appendix C

Outcome Evaluation Data Collection and Analysis Matrix

Indicator	Role of Indicator	Data Source	Frequency	Responsibility	Statistical Test
Pre- and Post-Chemistry Exam	To measure changes in students' chemistry content knowledge and skills	June 205 and January 2016 New York State Regents Exam	Administered twice: August 2016 and January 2017	Teachers	Split-Plot ANOVA One-way ANOVA Effect size
Student Interest	To measure students' inclination to enroll in advanced level science courses	School course request records	Administered twice: August 2016 (data from January 2015) and February 2017	Researcher	Split-Plot ANOVA Effect Size

Appendix D

Process Evaluation Data Collection and Analysis Matrix

Fidelity Indicator	Data Source(s)	Data Collection Tool	Frequency	Responsibility	Statistical Test
Teacher Professional Development on Student Self-Efficacy. Professional development will use *Making a Difference: Classroom Strategies that Motivate Students* (Siegle, Owen, & Reis, 1995)	Teachers' knowledge and skills on how to increase student self-efficacy Teacher attendance for professional development	*Teacher Efficacy Awareness Form, Teacher Survey*, & *Daily Strategy Form* (Siegle, 1995) Attendance logs for professional development	Teachers in the treatment group completed: The *Teacher Awareness Form* once after the professional development was completed; The *Teacher Survey* twice, once before and after the professional development; The *Daily Strategy Form* each day during the treatment. Teachers of the control group completed the *Teacher Survey* twice, once at the beginning and end of the intervention. Attendance was taken during each professional development session	Teachers completed the *Awareness form*, surveys, and *Daily Strategy Form* The researcher took attendance during each professional development session	Descriptive statistics

Teacher Professional Development on Differentiated Instruction. Professional development will use *How to Differentiate Instruction in Mixed-Ability Classrooms* (Tomlinson, 2001)	Teachers' self-efficacy for implementing differentiated instructional strategies Implementation of differentiated instructional strategies Teacher attendance for professional development	Survey items 1, 2, 4, 5, 7, and 8 on the *Teacher Self-Efficacy Scale* that address efficacy for instructional strategies as they relate to differentiated instruction and survey items 17-24 that address efficacy for student engagement (Tschannen-Moran & Woolfold Hoy, 2001). Qualitative classroom observations (Thomlinson, 1995) Observations of common planning time Attendance logs for professional development	Teachers in treatment and control groups completed the survey before and after professional development on differentiated instruction Teachers in the control completed the survey once at the beginning and end of the intervention A total of 12 classroom observations (six for the treatment and six for the control) were conducted over the six-month treatment Weekly observation notes of common planning time Attendance at Professional development sessions	Teachers completed the surveys The researcher completed the classroom observations and take attendance during each professional development session	Descriptive Statistics
Teacher Professional development on students'	Teachers' knowledge and skills on how to strengthen	Survey on measuring mindset (Dweck, 2016)	Teachers in treatment completed the survey before and after	Teachers completed the surveys	Descriptive statistics

ability and intelligence Professional development will use *Mindset:The New Psychology of Success* (Dweck, 2006)	students' growth mindset Implementa-tion of Growth Mindset strategies Teacher attendance for professional development	Observations of common planning time Classroom observations Attendance logs for professional development	professional development on mindsets Teachers in the control took the survey once at the beginning and end of the intervention. Weekly observation notes of common planning time Classroom observations Attendance for professional development sessions	The researcher took attendance during each professional development session, conducted common planning time and classroom observations	
Student Engagement	Students' engagement in chemistry class	*Student Self-Report Survey on Engagement* (Appleton, 2006)	Students in treatment and control groups completed the survey once at the end of treatment	Teachers will administer survey to students	t-test for independen t samples
Student Interest in Chemistry	Students' interest in chemistry class	*STEM Semantics Survey* and *Career Interest Questionnair e* will be adapted to focus students on their chemistry class (Tyler-	Students in treatment and control groups completed the survey once at the beginning and end of treatment	Teachers administered survey to students	Split-Plot ANOVA Effect Size

		Wood, Knezek, and Christensen, 2010)			
Student self-efficacy	Students' Self-Efficacy in chemistry class	*Self-Efficacy Question-naire* (Zimmer-man, Bandura, & Martinez-Pons, 1992)	Students in treatment and control groups completed the survey once at the end of treatment	Teachers administered survey to students	t-test for independen t samples
Dosage of Intervention	Student Attendance	Daily attendance recorded in online Gradebook	Each chemistry class	Teachers recorded attendance	N/A
Frequency of Student Support	Student attendance for tutoring and frequency and type of in-class support	Daily attendance recorded by the teacher during tutoring hours Daily log of students who receive in-class support and the type of support received	Each school day	Teachers recorded attendance for tutoring sessions and in-class student aides recorded the students who received support and the type of support received	Descriptive statistics
Participant Responsivene ss	Opinions and perceptions of teachers and students	RTOP Observation Tool; Qualitative Classroom observations and semi-structured interviews	A total of 12 classroom observations (six for the treatment and six for the control) were made over the six-month treatment. Treatment group teachers were interviewed at the conclusion of	The researcher and a second observer completed the classroom observations The researcher completed the interviews	t-test for independen t samples and descriptive statistics

	the intervention Six students were interviewed at the conclusion of the intervention	

Appendix E

Teacher Survey on Student Self-Efficacy

Directions: Your responses are confidential. Read each sentence and decide how confident you are about completing the tasks described in the statements below. Circle 1, 2, 3, 4, 5, 6, or 7. The larger the number you circle, the more confident you believe you are at the task. Circle only one answer for each statement. In the example below, the respondent indicated that she was fairly confident at snot skiing by circling 5.

How much confidence do you have about doing each of the behaviors listed below?

	Very Little ←----------------→ Extremely high						
Example: Snow Skiing	1	2	3	4	5	6	7
1. Complimenting students in a variety of ways on their skills	1	2	3	4	5	6	7
2. Showing students that they have achieved the lesson objectives	1	2	3	4	5	6	7
3. Identifying students who have mastered a skill	1	2	3	4	5	6	7
4. Attributing student success to the student's ability or acquired skills	1	2	3	4	5	6	7
5. Reviewing previously mastered material with students	1	2	3	4	5	6	7
6. Understanding self-efficacy strategies	1	2	3	4	5	6	7
7. Knowing when a student probably does not know the answer to a question	1	2	3	4	5	6	7
8. Posting the lesson objectives at the start of the lesson	1	2	3	4	5	6	7
9. Applying self-efficacy strategies in my classroom	1	2	3	4	5	6	7
10. Telling students that they are good at a skill	1	2	3	4	5	6	7
11. Sharing lesson objectives with the class	1	2	3	4	5	6	7
12. Calling on students who can correctly answer a question	1	2	3	4	5	6	7
13. Complimenting students on a skill they have mastered	1	2	3	4	5	6	7
14. Reviewing the objectives of the lesson at the end of a lesson	1	2	3	4	5	6	7
15. Helping students draw attention to the skills they have acquired	1	2	3	4	5	6	7
16. Using self-efficacy strategies during my teaching	1	2	3	4	5	6	7
17. Avoiding calling on a student who cannot answer a question	1	2	3	4	5	6	7
18. Selecting students who can successfully demonstrate a skill to the class	1	2	3	4	5	6	7
19. Using self-efficacy strategies during instruction in chemistry.	1	2	3	4	5	6	7

Appendix F

Daily Strategy Form

At the end of the daily chemistry lesson, please take a minute to record which strategies you successfully used. Indicate any unusual or unexpected circumstances under the Comments section. Please update this form daily.

	Mon	Tues	Wed	Thurs	Fri	Comments
Goals						
1. Started lesson with a review of previous day's accomplishments						
2. Posted today's chemistry goals (skills)						
3. Reviewed and checked goals (skills) achieved in today's lesson						
4. Allowed students time to write in their calendars						
5. Reviewed at least two students' calendars with them						
Teacher Feedback Emphasizing Student Skills						
6. Complimented the class at least four times during the lesson on the skills it had mastered						
7. Privately complimented at least five students (verbally or on their papers) on how good they were at a skill						
Models						
8. Early in a lesson had at least one student successfully demonstrated a measurement technique to the class						
9. (Optional) Videotaped or photographed the class working and showed the class the tape or photographs, drawing attention to how "good they were at the specific skill they were doing"						

Appendix G

Teacher Efficacy Awareness Form

Directions: Please complete this form after you complete all of the professional development modules on self-efficacy. A one-sentence response to each question is sufficient. Submit this form to Matthew Paushter prior to the start of the school year. You may use any information that was provided in the modules or sent to you for this study to answer these questions. Your responses will not be shared with anyone other than the researchers. We will use this form to clarify any misunderstanding that may exist about the specific strategies you are implementing on a daily basis during the six months of this study.

1. At the beginning of each lesson, you review the skills the students learned from the previous lesson. Why should this review increase your students' confidence?
2. Prior to starting a new lesson, you post the skills to be learned in the new lesson and leave them posted during the lesson. At the end o the lesson, you review with the class what has been learned and you draw a mark in front of each skill you covered. Why do you think it is necessary to physically indicate with a mark that the skill has been achieved?
3. At the end of the lesson, the students record on their calendars something new they learned, or something at which they excelled during the lesson. Why is it necessary for the student to do this daily?
4. Why is it important for you to spend a few minutes individually reviewing the student calendars with a few students each day?
5. During the six months, you make an added effort to compliment individual students and your class on their ability in specific skills they use. Why is it important to draw attention to their specific skills?
6. Imagine that a student name Mary has just successfully estimated the length of a bookshelf. How might you compliment her?
7. Imagine that a student named Juan worked very hard and has answered all but one question correctly on a measurement conversion assignment. What might you say to Juan?
8. Why is it advantageous to have student models successfully demonstrate the new skills as early as possible during each lesson?

Appendix H

Teachers' Sense of Efficacy for Differentiated Instruction

Directions: The questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in mixed ability classes. Please indicate your opinion about each of the statements below. Your answers are confidence and will only be shared with the researchers.

	Nothing (1)	(2)	Very Little (3)	(4)	Some Influence (5)	(6)	QuIte A Bit (7)	(8)	A Great Deal (9)
1. To what extent can you use a variety of assessment strategies?									
2. To what extent can you provide an alternative explanation or example when students are confused?									
3. How well can you implement alternative strategies in your classroom?									
4. How much can you do to adjust your lessons to the proper level for individual students?									
5. To what extent can you gauge student comprehension of what you have taught?									
6. How well can you provide appropriate challenges for very capable students?									
7. How much can you do to get students to believe they can do well in schoolwork?									
8. How much can you do to help your students' value learning?									
9. How much can you do to motivate students who show low interest in schoolwork?									
10. How much can you assist families in helping their children do well in school?									

11. How much can you do to improve the understanding of a student who is failing?									
12. How much can you do to help your students think critically?									
13. How much can you do to foster student creativity?									
14. How much can you do to get through to the most difficult students?									

Appendix I

Measuring Mindset

Directions: Your responses are confidential and will only be shared with the researchers. Read each sentence and decide the extent to which you agree or disagree with each statement. The larger the number you circle, the more confident you believe you are at the task.

	Strongly Agree	Agree	Mostly Agree	Disagree	Strongly Disagree
1. You have a certain amount of intelligence, and you can't really do much to change it					
2. Your intelligence is something about you that you can't change very much					
3. No matter who you are, you can significantly change your intelligence level					
4.To be honest, you can't really change how intelligent you are					
5. You can always substantially change how intelligent you are					
6. You can learn new things, but you can't really change your basic intelligence					
7. No matter how much intelligence you have, you can always change it quite a bit					
8. You can change your basic intelligence level considerably					
9. You have a certain amount of talent, and you can't really do much to change it					
10. Your talent in an area is something about you that you can't change very much					
11. No matter who you are, you can significantly change your level of talent					
12. To be honest, you can't really change how much talent you have					
13. You can always substantially change how much talent you have					
14. You can learn new things, but you can't really change your basic level of talent					
15. No matter how much talent you have, you can always change it quite a bit					
16. You can change even your basic level of talent considerably					

Appendix J

Student Engagement Survey

Directions: This survey will help the researchers learn more about your engagement in chemistry class and in school. Your answers to the survey are confidential and will only be shared with the researchers. They will not be shared with your teachers or anyone else at the school. For each question, select how much you agree or disagree with the statement.

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
1. Overall, my chemistry teacher treats students fairly				
2. My chemistry teacher listens to the students				
3. My chemistry teacher cares about his/her students				
4. My chemistry teacher is there for me when I need him/her				
5. The rules in chemistry class are fair				
6. My chemistry teacher is open and honest with me				
7. I enjoy talking to my chemistry teacher				
8. I feel safe in chemistry class				
9. My chemistry teacher is interested in me as a person, not just as a student				
10. The chemistry tests in the course do a good job of measuring what I'm able to do				
11. What I am learning in chemistry class is important				
12. My grades in chemistry class do a good job of measuring what I'm able to do				
13. What I'm learning in my chemistry class will be important in my future				
14. After finishing my chemistry schoolwork I check it over to see if it's correct				
15. When I do my chemistry schoolwork I check to see whether I understand what I'm doing				
16. Learning is fun because I get better at something				
17. When I do well in school it's because I work hard				
18. I feel like I have a say about what happens to me in chemistry class				
19. Other students in my chemistry class care about me				

20. Students in chemistry class are there for me when I need them				
21. Other students in my chemistry class like me the way I am				
22. I enjoy talking to other students in chemistry class				
23. Students in chemistry class respect what I have to say				
24. I have some friends in chemistry class				
25. I plan to continue my education following high school				
26. Going to school after high school is important				
27. School is important for achieving my future goals				
28. My education will create many future opportunities for me				
29. I am hopeful about my future				
30. My family/guardian(s) are there for me when I need them				
31. When I have problems at school my family/guardian(s) are willing to help me				
32. When something good happens at school, my family/guardian(s) want to know about it				
33. My family/guardian(s) want me to keep trying when things are tough at school				
34. I'll learn, but only if my family/guardian(s) give me a reward				
35. I'll learn, but only if my chemistry teacher gives me a reward				

Appendix K

Student Interest in Science Survey

Directions: This questionnaire is designed to assess your perceptions of scientific disciplines. It should require about 5 minutes of your time. Usually it is best to respond with your first impression, without giving a question much thought. Your answer will remain confidential and will only be shared with the researchers. Your answers will not be shared with your teacher or anyone else at the school.

Choose one circle between each adjective pair to indicate how you feel about the object.

To me, SCIENCE is:

1.	fascinating	1	2	3	4	5	6	7	dull
2.	appealing	1	2	3	4	5	6	7	unappealing
3.	exciting	1	2	3	4	5	6	7	unexciting
4.	Meaning nothing	1	2	3	4	5	6	7	means a lot
5.	interesting	1	2	3	4	5	6	7	boring

To me, a CAREER in science is:

1.	means nothing	1	2	3	4	5	6	7	means a lot
2.	boring	1	2	3	4	5	6	7	interesting
3.	exciting	1	2	3	4	5	6	7	unexciting
4.	fascinating	1	2	3	4	5	6	7	dull
5.	appealing	1	2	3	4	5	6	7	unappealing

Appendix L

Student Self-Efficacy Survey

Directions: This questionnaire is designed to assess your perceptions of how well you can perform a set of tasks. It should require about 3 minutes of your time. Usually it is best to respond with your first impression, without giving a question much thought. Your answer will remain confidential and will only be shared with the researchers. Your answers will not be shared with your teacher or anyone else at the school.

How well can you:	Not well at all (1)	(2)	Not too well (3)	(4)	Pretty well (5)	(6)	Very well (7)
1. finish your chemistry homework assignments by deadlines?							
2. study chemistry when there are other interesting things to do?							
3. concentrate on chemistry?							
4. take chemistry class notes of class instruction?							
5. use sources (internet, media center resources, textbook, etc.) to get information for class assignments?							
6. plan your chemistry schoolwork?							
7. organize your chemistry schoolwork?							
8. remember information presented in chemistry class, textbook, or other resources used in class?							
9. arrange a place to study chemistry without distractions?							
10. motivate yourself to do schoolwork?							
11. learn chemistry?							

Appendix M

Johns Hopkins University
Homewood Institutional Review Board (HIRB)

Assent Form

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

We want to tell you about a research study we are doing during the 2016-2017 school year. A research study is a way to learn more about something. We would like to find out more about how student interest and achievement in science can be increased. You are being asked to join the study because you have been randomly selected to participate in the study and we feel that your participation is important.

If you agree to join this study, you will respond to a few short surveys and take a chemistry content and skills test at the beginning and end of the study. Your responses to the surveys and score on the chemistry test will not affect your course grade. You may be asked to participate in a 30-minute interview at the end of the study.

There are no anticipated risks to your participation in the study.

This study will help us learn more about how schools and teachers can help all students find an interest in science and to earn good grades.

You do not have to join this study. It is up to you. You can say okay now and change your mind later. All you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and stop.

Before you say **yes or no** to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher, Mr. Paushter, that you have a question. You may also contact another researcher, Ms. Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you want to be in this study, please sign your name. You will get a copy of this form to keep.

____ ____________________________

Student Signature **Date**

Appendix N

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Assent Form

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

We want to tell you about a research study we are doing during the 2016-2017 school year. A research study is a way to learn more about something. We would like to find out more about how student interest and achievement in science can be increased. You are being asked to join the study as a student tutor.

If you agree to join this study, you will be asked to support an honors chemistry teacher with instruction to a class of students. You will also be asked to journal your interactions with students on a daily basis. You may be asked to participate in a 30-minute interview at the end of the study.

There are no anticipated risks to your participation in the study.

This study may help us learn more about how schools and teachers can help all students find an interest in science and to earn good grades.

You do not have to join this study. It is up to you. You can say okay now and change your mind later. All you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and stop.

Before you say **yes or no** to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher, Mr. Paushter, that you have a question. You may also contact another researcher, Ms. Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you want to be in this study, please sign your name. You will get a copy of this form to keep.

____ ________________________

Student Signature **Date**

Appendix O

Johns Hopkins University
Homewood Institutional Review Board (HIRB)

Assent Form

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

We want to tell you about a research study we are doing during the 2016-2017 school year. A research study is a way to learn more about something. We would like to find out more about how student interest and achievement in science can be increased. You are being asked to join the study because you have been randomly selected to participate in the study and we feel that your participation is important.

If you agree to join this study, you will be asked to enroll in an honors chemistry class with other students participating in the study. You will receive enhanced instruction to engage you in science content, activities, and experiments. You will also have the opportunity to receive support with homework and class work with people other than your teacher. You will respond to a few short surveys and take a chemistry content and skills test at the beginning and end of the study. Your responses to the surveys and score on the chemistry test will not affect your course grade. You may be asked to participate in a 30-minute interview at the end of the study.

There are no anticipated risks to your participation in the study.

We do not know if being in this study will help you. We expect that the study will help you by increasing your interest and grades in science. We may learn something that will help other children with learning science some day. This study will help us learn more about how schools and teachers can help all students find an interest in science and to earn good grades.

You do not have to join this study. It is up to you. You can say okay now and change your mind later. All you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and stop.

Before you say **yes or no** to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher, Mr. Paushter, that you have a question. You may also contact another researcher, Ms. Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you want to be in this study, please sign your name. You will get a copy of this form to keep.

Student Signature	**Date**

Appendix P

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Parental Permission Form

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

PURPOSE OF RESEARCH STUDY: The purpose of this research study is to increase students' interest and achievement in science. We anticipate that approximately 128 students will participate in this study.

PROCEDURES:
The study will run from August 2016 through January 2017. Students participating in the study will be enrolled in the chemistry course that they requested. Students will receive the same curriculum and instruction as students not participating in the study. Students participating in the study will complete three short surveys at the beginning and end of the study. Students will also take a chemistry content and skills test at the beginning and end of the study. Students may be selected to participate in a 30-minute interview at the conclusion of the study.

RISKS/DISCOMFORTS:
The risks associated with participation in this study are no greater than those encountered in daily life or during the performance of routine psychological examinations or tests.

BENEFITS:
This study may benefit students if the results lead to a better understanding of how schools and teachers can better provide challenging curriculum and instruction to all students.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:
Your child's participation in this study is entirely voluntary: You choose whether to allow your child to participate, and we will also ask your child whether he or she agrees to take part in the study. If you decide not to allow your child to participate, or your child chooses not to participate, there are no penalties, and neither you nor your child will lose any benefits to which you would otherwise be entitled.If you and your child choose to participate in the study, you or your child can stop participation at any time, without any penalty or loss of benefits. If you want to withdraw your child from the study, or your child wants to stop participating, please submit notification of your intent to withdraw your child from the study to Matthew Paushter, Assistant Principal, at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org.

CONFIDENTIALITY:
Any study records that identify your child will be kept confidential to the extent possible by law. The records from your child's participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify your child will be available only to people working on the study, unless you give permission for other people to see the records.

All electronic study records will be kept on a private, password-protected computer. Hard copies of study records will be kept in a locked file cabinet. All data sheets will use code numbers rather than participants' names to ensure confidentiality.

Cost:
There is no cost to participate in this study.

COMPENSATION:
You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You and your child can ask questions about this research study now or at any time during the study, by talking to the researcher working with you and your child or by calling Matthew Paushter at 301-601-4660. You may also contact another researcher, Heather Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

SIGNATURES:

WHAT YOUR SIGNATURE MEANS:

Your signature below means that you understand the information in this consent form. Your signature also means that you agree to allow your child to participate in the study. Your child's signature indicates that he or she agrees to participate in the study.

By signing this consent form, you and your child have not waived any legal rights your child otherwise would have as a participant in a research study.

Child's Name

Child's Signature (if applicable)	**Date**
Signature of Parent	**Date**
Signature of Second Parent (if required)	**Date**
Signature of Legal Guardian (if applicable)	**Date**
Signature of Person Obtaining Consent **(Investigator or HIRB-Approved Designee)**	**Date**
Witness to Consent Procedures (if required by HIRB)	**Date**

Appendix Q

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Parental Permission Form - Tutors

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

PURPOSE OF RESEARCH STUDY:

The purpose of this research study is to increase students' interest and achievement in science.

We anticipate that approximately four student tutors and 128 students will participate in this study.

PROCEDURES:

The study will run from August 2016 through January 2017. Student tutors participating in the study will be enrolled as a teaching assistant in an honors chemistry course. Students will assist the teacher in delivering instruction and supporting honors chemistry students. Students will be asked to journal their interactions with students on a daily basis. Students may be selected to participate in a 30-minute interview at the conclusion of the study.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life or during the performance of routine psychological examinations or tests.

BENEFITS:

This study may benefit students if the results lead to a better understanding of how schools and teachers can better provide challenging curriculum and instruction to all students.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

Your child's participation in this study is entirely voluntary: You choose whether to allow your child to participate, and we will also ask your child whether he or she agrees to take part in the study. If you decide not to allow your child to participate, or your child chooses not to participate, there are no penalties, and neither you nor your child will lose any benefits to which you would otherwise be entitled.

If you and your child choose to participate in the study, you or your child can stop participation at any time, without any penalty or loss of benefits. If you want to withdraw your child from the study, or your child wants to stop participating, please submit notification of your intent to withdraw your child from the study to Matthew Paushter, Assistant Principal at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org.

Confidentiality:

Any study records that identify your child will be kept confidential to the extent possible by law. The records from your child's participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify your child will be available only to people working on the study, unless you give permission for other people to see the records.

All electronic study records will be kept on a private, password-protected computer. Hard copies of study records will be kept in a locked file cabinet. All data sheets will use code numbers rather than participants' names to ensure confidentiality.

Cost:

There is no cost to participate in this study.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You and your child can ask questions about this research study now or at any time during the study, by talking to the researcher working with you and your child or by calling Matthew Paushter at 301-601-4660. You may also contact another researcher, Heather Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

SIGNATURES

WHAT YOUR SIGNATURE MEANS:

Your signature below means that you understand the information in this consent form. Your signature also means that you agree to allow your child to participate in the study. Your child's signature indicates that he or she agrees to participate in the study.

By signing this consent form, you and your child have not waived any legal rights your child otherwise would have as a participant in a research study.

Child's Name	
Child's Signature (if applicable)	**Date**
Signature of Parent	**Date**
Signature of Second Parent (if required)	**Date**
Signature of Legal Guardian (if applicable)	**Date**
Signature of Person Obtaining Consent **(Investigator or HIRB-Approved Designee)**	**Date**
Witness to Consent Procedures (if required by HIRB)	**Date**

Appendix R

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Parental Permission Form – Student Treatment

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

PURPOSE OF RESEARCH STUDY:

The purpose of this research study is to increase student interest and achievement in science.

We anticipate that approximately 128 students will participate in this study.

PROCEDURES:

The study will run from August 2016 through January 2017. Students participating in the study will be enrolled in an honors chemistry course. Students participating in the study will receive enhanced instruction and support to engage them in learning and experiencing science concepts, activities, and experiments. Northwest High School chemistry teachers will teach all students participating in this study. Students will complete three short surveys at the beginning and end of the study. Students will also take a chemistry content and skills test at the beginning and end of the study. Students may be selected to participate in a 30-minute interview at the conclusion of the study.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life or during the performance of routine psychological examinations or tests.

BENEFITS:

This study is intended to increase students' interest and achievement in science. Students participating in the study will receive enhanced instruction to engage them in science concepts, activities, and experiments. Students participating in the study will also be provided opportunities to receive additional support in- and out-of-class (e.g., tutoring support). Students will also receive instruction and support from their teachers to help build their self-confidence and motivation to learn science.

This study may benefit students if the results lead to a better understanding of how schools and teachers can better provide challenging curriculum and instruction to all students.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

Your child's participation in this study is entirely voluntary: You choose whether to allow your child to participate, and we will also ask your child whether he or she agrees to take part in the study. If you decide not to allow your child to participate, or your child chooses not to participate, there are no penalties, and neither you nor your child will lose any benefits to which you would otherwise be entitled.

If you and your child choose to participate in the study, you or your child can stop participation at any time, without any penalty or loss of benefits. If you want to withdraw your child from the study, or your child wants to stop participating, please submit notification of your intent to withdraw your child from the study to Matthew Paushter, Assistant Principal at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org. While a student may withdraw from the study at anytime, the student may need to remain in the assigned class until second semester due to scheduling constraints. If a student withdraws but must remain in the class then they will no longer participate in data collection activities such as surveys, interviews, or achievement tests.

CONFIDENTIALITY:

Any study records that identify your child will be kept confidential to the extent possible by law. The records from your child's participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify your child will be available only to people working on the study, unless you give permission for other people to see the records.

All electronic study records will be kept on a private, password-protected computer. Hard copies of study records will be kept in a locked file cabinet. All data sheets will use code numbers rather than participants' names to ensure confidentiality.

COST:

There is no cost to participate in this study.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You and your child can ask questions about this research study now or at any time during the study, by talking to the researcher working with you and your child or by calling Matthew Paushter at 301-601-4660. You may also contact another researcher, Heather Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

SIGNATURES:

WHAT YOUR SIGNATURE MEANS:

Your signature below means that you understand the information in this consent form. Your signature also means that you agree to allow your child to participate in the study. Your child's signature indicates that he or she agrees to participate in the study.

By signing this consent form, you and your child have not waived any legal rights your child otherwise would have as a participant in a research study.

Child's Name

Child's Signature (if applicable) **Date**

Signature of Parent **Date**

Signature of Second Parent (if required) **Date**

Signature of Legal Guardian (if applicable) **Date**

Signature of Person Obtaining Consent **Date**
(Investigator or HIRB-Approved Designee)

Witness to Consent Procedures (if required by HIRB) **Date**

Appendix S

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Informed Consent Form – Teacher Control

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

PURPOSE OF RESEARCH STUDY:

The purpose of this research study is to measure the effectiveness of an Honors mixed ability chemistry class on student interest and achievement in science. We anticipate that approximately four teachers and 132 students will participate in this study.

PROCEDURES:

The study will run from August 2016 through January 2017. As a participant in the control group of this study, you will complete three short surveys at the beginning and end of the study and maintain a daily instructional activity log for the duration of the study. The researcher will periodically observe your class throughout the study and you may be asked to participate in a 30-minute interview at the conclusion of the study.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life or during the performance of routine psychological examinations or tests.

BENEFITS:

This study may benefit students if the results lead to a better understanding of how schools and teachers can provide challenging curriculum and instruction to all students within mixed ability classes.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

Your participation in this study is entirely voluntary: You choose whether to participate. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled. If you choose to participate in the study, you can stop your participation at any time, without any penalty or loss of benefits. If you want to withdraw from the study, please submit in writing to Matthew Paushter, Assistant Principal at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org.

CONFIDENTIALITY:

Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for

making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.
All electronic study records will be kept on a private, password-protected computer. Hard copies of study records will be kept in a locked file cabinet. All data sheets will use code numbers rather than participants' names to ensure confidentiality.

COST:
There is no cost to participate in this study.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You can ask questions about this research study now or at any time during the study, by talking to the researcher(s) working with you or by calling Matthew Paushter at 301-601-4660. You may also contact another researcher, Heather Yuhaniak, at Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.you have about the study.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

SIGNATURES

WHAT YOUR SIGNATURE MEANS:
Your signature below means that you understand the information in this consent form. Your signature also means that you agree to participate in the study.
By signing this consent form, you have not waived any legal rights you otherwise would have as a participant in a research study.

Participant's Signature **Date**

Signature of Person Obtaining Consent **Date**
(Investigator or HIRB Approved Designee)

Appendix T

Johns Hopkins University

Homewood Institutional Review Board (HIRB)

Informed Consent Form

Title:	Detracking in Science
Principal Investigator:	Dr. Carolyn Parker, Johns Hopkins University
Date:	March 30, 2016

PURPOSE OF RESEARCH STUDY: The purpose of this research study is to measure the effectiveness of an Honors mixed ability chemistry class on student interest and achievement in science. We anticipate that approximately four teachers and 132 students will participate in this study.

PROCEDURES: The study will run from August 2016 through January 2017. As a participant in this study, you will be required to participate in multiple professional development activities. These activities include reading two books, completing a two hour on-line professional development module, meeting with the researcher for two hours prior to the start of the 2016-2017 school year to review book readings, and engage in collaborative planning with colleagues and the researcher during weekly common planning time throughout the study. You will also be required to complete three short surveys at the beginning and end of the study and maintain a daily instructional activity log for the duration of the study. In addition, you will meet with the researcher for a 30-minute interview at the conclusion of the study.

RISKS/DISCOMFORTS:

The risks associated with participation in this study are no greater than those encountered in daily life or during the performance of routine psychological examinations or tests.

BENEFITS:

This study is intended to enhance your teaching knowledge, skills, and beliefs about teaching and learning. The professional development you receive throughout the study is likely to positively impact your instruction and ability to work with a diverse set of learners.

This study may benefit society if the results lead to a better understanding of how schools and teachers can provide challenging curriculum and instruction to all students within mixed ability classes.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:

Your participation in this study is entirely voluntary: You choose whether to participate. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled.

If you choose to participate in the study, you can stop your participation at any time, without any penalty or loss of benefits. If you want to withdraw from the study, please submit in writing to Matthew Paushter, Assistant Principal at Northwest High School, or Heather Yuhaniak, research member, at Heather_E_Yuhaniak@mcpsmd.org.

CONFIDENTIALITY:

Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the National Institutes of Health and the Office for Human Research Protections. (All of these people are required to keep your identity confidential.) Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

All electronic study records will be kept on a private, password-protected computer. Hard copies of study records will be kept in a locked file cabinet. All data sheets will use code numbers rather than participants' names to ensure confidentiality.

COST:

There is no cost to participate in this study.

COMPENSATION:

You will not receive any payment or other compensation for participating in this study.

IF YOU HAVE QUESTIONS OR CONCERNS:

You can ask questions about this research study now or at any time during the study, by talking to the researcher(s) working with you or by calling Matthew Paushter at 301-601-4660. You may also contact another researcher, Heather Yuhaniak, at

Heather_E_Yuhaniak@mcpsmd.org with any questions you have about the study.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at (410) 516-6580.

SIGNATURES

WHAT YOUR SIGNATURE MEANS:
Your signature below means that you understand the information in this consent form. Your signature also means that you agree to participate in the study.

By signing this consent form, you have not waived any legal rights you otherwise would have as a participant in a research study.

Participant's Signature **Date**

Signature of Person Obtaining Consent **Date**
(Investigator or HIRB Approved Designee)

Biographical Sketch

Matthew K. Paushter obtained his bachelor's degree from Franklin and Marshall College in 2001 and completed his Master of Education degree in 2005 from The George Washington University. Paushter completed his doctoral degree in education from Johns Hopkins University in 2017. He has been an educator for 16 years and is currently an assistant principal in Montgomery County Public Schools in Maryland.