# The Effects of Teacher-Student Racial and Ethnic Congruence on Student Math Learning

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(ABSTRACT)

The Supreme Court of the United States has recently determined that assigning students to schools and classrooms based on racial identity is unconstitutional. However, it also left the door open for further and different rulings. If researchers are able to show that lack of consideration of race has deleterious effects on federally mandated programs and initiatives, the ruling may be modified or opened up to specific circumstances. Among its many consequences, this ruling brings a focus onto the question of student-teacher matching in classrooms. Over the years, there has been a great deal of discussion in the literature about matching teacher and student by race, ethnicity, gender, and language. Some people claim that matching is crucial for student success while others dispute this claim. The current study examines the question of racial and ethnic matching empirically in the context of a large-scale randomized controlled study of an innovation for middle school mathematics learners. It extends the literature by (1) focusing on the relationship between student-teacher match and a specific, heavily documented situation with targeted learning goals, (2) adding information about Hispanic students to the discussion, and (3) helping evaluate factors that may be important in determining the validity of large-scale experiments. Alone and in conjunction with other similar empirical evidence, it will also have a significant effect on federal and state educational policy. The sample consists of the 92 teachers and 1576 7$^{th}$ grade students on 76 school campuses throughout 8 Texas regions who participated in the Scaling-Up SimCalc project. Teachers and students either used SimCalc Mathworlds ™ curriculum and technology or a control for a two-week replacement unit. The crux of the current analysis was a match between aggregated and individual teacher and student characteristics and an inquiry into how these matches influence student math performance in the classroom within and between our experimental and control group. Hierarchical Linear Modeling (HLM) analysis was used to investigate the differences in student mathematics performance, modeled as students nested in classrooms nested in schools.

DEDICATION

This dissertation is dedicated to my family and dearest friends. I especially dedicate this research project to my daughter; Reneisha Stroter, my mom; Debra Johnson, my only sister and her family; Kimberly, David, India, and Daniel Williams and my colleague; Katrina Landon.

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The last five years at Virginia Tech have been the most trying times of my life. I have gone through so many major life transitions. I am proud to say that despite the life changes and the length of time spent pursuing this degree; I am among the first of my entering cohort of five colleagues to complete a doctoral degree program. Earning a doctorate degree has been the most fruitful and keen period in my life to this point. My growth in reading, writing and arithmetic have all contributed to my keen interest, comprehension, and involvement in research and evaluation.

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# DISSERTATION OUTLINE

## Organization of the Study

This dissertation research is organized into three chapters; an outline chapter, an introductory chapter and a journal article. Chapter one outlines how the dissertation is organized. Chapter two introduces the study by providing background and rationale for the study. Chapter two also includes a statement of the problem, the purpose of the study, the research questions and hypotheses, definitions of key terms, significance of the study, limitations, and delimitations of the study. The third chapter is a journal article on race and ethnicity; race still matters in the classroom. The article includes a review of the relevant literature on teacher-student racial and ethnic congruence, the methodology of the study, including research design, sampling techniques, instruments used in data collection, and procedures on how the data will be analyzed. In addition, embedded in the article are the results of the study, discussion of the results, conclusions and implications for future research. The article will be submitted to a peer-reviewed scholarly journal; American Education Research Journal (AERJ) for publication. Finally, the dissertation work is posted onto the Electronic Dissertation Thesis (ETD) at Virginia Polytechnic and State University.

# CHAPTER TWO

# INTRODUCTION

## Background and Rationale

The Supreme Court of the United States recently determined that assigning students to schools and classrooms based on racial identity is unconstitutional, despite the fact that many studies have shown that race plays a major role in student-teacher interaction (Alexander, Entwisle, & Thompson, 1987; Ainsworth-Darnell, & Downey, 1998; Brewer, Ehrenberg & Goldhaber, 1994; Downey & Pribesh, 2004; Farkas et al., 1990; Ferguson, 2003; Irvine, 1986; Oates, 2003). However, it also left the door open for further and different rulings. If researchers are able to show that lack of consideration of race has deleterious effects on federally mandated programs and initiatives, the ruling may be modified or opened up to specific circumstances. Among its many consequences, this ruling brings into focus the question of student-teacher matching in classrooms. Over the years, there has been a great deal of discussion in the literature about matching teacher and student by race, ethnicity, gender, and language. Some people claim that race should not be considered when organizing or evaluating the classroom and that, therefore, matching should not even be considered. Others are willing to consider matching, but disagree about whether it is effective or not (Muller, 1998; Oats, 2003).

Several reasons have been given for the importance of a match between students and teacher. First, pedagogy should be culturally responsive to build an "intimate connection between knowledge considered basic to any school curriculum and knowledge that is the fruit of the lived experiences of these students as individuals" (Paulo, 1998, p. 21). Yet, research shows that only 17% of public school teachers believe that they were adequately prepared to teach culturally and linguistically diverse student populations (White-Clark, 2005). Second, the absence of matching (minority students being taught by White teachers not minority teachers) may contribute to teachers' low expectations of Hispanic and African-American students (Jamar & Pitts, 2005). More subtly, Oats (2003) suggests that that the match between teacher and students shapes teacher perceptions of student performance. Some studies suggest that White teachers assess the White students as more academically engaged than the black students (Downey & Pribesh, 2004; Ferguson, 2003). Other studies suggest that White teachers give black students worse evaluations than black teachers tend to give them (Alexander, Entwisle, &

Thompson, 1987; Brewer, Ehrenberg & Goldhaber, 1994; Downey & Pribesh, 2004; Ferguson, 2003).

Some research has suggested that any negative impact of matching is more pronounced when a White teacher is matched with African-American classrooms than the other way around. This study pursues the question of racial and ethnic matching in the context of data from a randomized, controlled study of middle school mathematics learning in Texas classrooms.

*Minority Student Mathematics Performance*

Research on mathematics performance among United States high school and middle school students shows that their performance lags behind that of many developed countries (Balfanz & Byrnes, 2006; Kaput & Roschelle, 1996; National Council of Teachers of Mathematics, 2000). One disproportionately affected group is minority students, particularly African-American and Hispanic, who perform on the average 45 points (see Table 1.1) below their White counterparts on $8^{th}$ grade National Assessment of Educational Progress (NAEP) examination (Balfanz & Byrnes, 2006; Jamar & Pitts, 2005; Mertens & Flowers, 2003). This low performance amongst minority students is a cause for concern for policy-makers, researchers, and educators, as well as the general public. Low performance in mathematics has serious implications for the students' futures.

Table 1.1

*NAEP National Mathematics Results for Grade 8 - Public Schools, Percentages of Students Below, At or Above Achievement Levels, By Race/Ethnicity, 2000*

| | | | Achievement Level | | | |
|---|---|---|---|---|---|---|
| Race/Ethnicity | N | Average Scale Score | Advanced | Proficient | Basic | Below Basic |
| White | 4988 | 285 | 6% | 34% | 77% | 23% |
| Black | 1854 | 246 | 0% | 5% | 32% | 68% |
| Hispanic | 1909 | 252 | 1% | 9% | 40% | 60% |
| Asian/Pacific Islander | 451 | 288 | 11% | 40% | 75% | 25% |
| American Indian | 133 | 261 | 0% | 12% | 50% | 50% |

*From the National Assessment of Educational Progress ("The Nation's Report Card"). Copyright, 2000 of the National Center for Educational Statistics, Permission of U.S. Department of Education, Public domain

Research has linked minority students' mathematics performance to several factors including socioeconomic status (Mertens & Flowers, 2003; Lubienski & Lubienski, 2005; McGraw et al., 2006), family attributes, cognitive and affective characteristics, school environment factors, equitable opportunities to learn more rigorous mathematics (Jamar & Pitts, 2005; Roschelle & Kaput, 1996; Tatar et al., 2007), teacher classroom practices, behaviors, attitude (Mertens & Flowers, 2003; Glass, 2000), and under-motivated students and teachers (Cammarota, 2006). It has also linked minority student mathematics performance to racial and ethnic differences between teacher and students (Downey & Pribesh, 2004; Oates, 2003), and to a lack of understanding of English language learners (Minami & Ovando, 2002).

Some researchers view the problem centrally located in the preparation of students at the middle school level (Anfara & Lipka, 2003). The achievement gap has been consistently reported to develop most rapidly between $5^{th}$ and $8^{th}$ grade (Balfanz & Byrnes, 2006). Whether it originates in middle school or not, it carries over from middle to high school, from high school to college and from either and/or both high-school and college to future employment prospects.

The gap in performance is related not only to individual students, but also to classroom level performance. Nearly 67% of black students and 73% of Hispanic students are nested in schools where at least 50% of the student population is minority students (Orfield & Yun, 1999). Yet, in many cases, almost all of the teachers are White (HR Exchange, 2004). High minority classrooms are more likely than predominately White classrooms to have lower levels of achievement.

## Statement of the Problem

It is important to understand the relationship between matching and improvements in minority achievement. Although strong claims for the importance of matching have been made, they have not been sufficient to persuade everyone, especially not the Supreme Court. Furthermore, middle school mathematics provides a particularly important arena for exploration because of its high impact on future life prospects for students.

## Purpose of the Study

The purpose of the current study was to examine the effects of teacher-student matching by race and ethnicity on middle-school students' mathematics proficiency, especially with respect to complex mathematical concepts such as rate and proportionality. Although the larger study in which the data set was gathered was focused on changes in curriculum, especially with respect to technology-use, the National Council of Teachers of Mathematics (2000) has claimed that one of the strongest links in the development of mathematical skill is the mathematics teacher. We explore the role of the mathematics teachers via the issue of matching.

Further exploration of the teacher's role and the importance of matching will be conducted by the inclusion of data about teachers' expectations, perceptions, attitudinal variables, and classroom practices, all or some of which have been claimed as important factors in the classroom and mediating variables in the impact of racial matching (Oberlander & Talbert-Johnson, 2004).

## Contextual Background of the Study

The strategy I employed in this study was to examine a data set gathered in the context of a large-scale controlled randomized trial of a particular approach to teaching middle school mathematics. This study is of interest in its own right but is of sufficient size and allows us to add questions about classroom innovation and change to those about matching. The study used a technology called Simcalc Mathworlds® and an associated curriculum and teacher professional development experience.

### *SimCalc Mathworlds and Math Performance*

It has been long suggested that the reason US math performance begins to lag behind in middle school is due to the lack of opportunity to learn more rigorous, complex and conceptually difficult mathematics (Kaput & Roschelle, 1997; Schmidt et al., 2001; Suter, 2002; & Tatar et al., 2007). The current analysis of matching is undertaken in the context of a study that attempts to provide increased opportunity for students to learn more complex mathematics.

SimCalc Mathworlds (www.simcalc.umassd.edu) is an innovative curriculum and software designed to enable middle school students to learn more rigorous and conceptually difficult mathematics. SimCalc Mathworlds was developed "to enable all children to learn the mathematics of change beginning in early grades" (Kaput & Roschelle, 1997). SimCalc Mathworlds lays the foundation for calculus through the use of a pedagogy utilizing representations that present change and variation through graphs, tables, and simulations as well as algebraic expressions (Hedges & Lesh, 2008). The researchers designed the curriculum using the properties of graphs in three major ways: (1) “to support manipulation of piecewise defined functions, a form that is extremely cumbersome in traditional algebra,” (2) “to democratize access to writing and manipulating graphs as opposed to more traditional forms of reading and interpreting graphs,” and (3) “to make powerful math concepts with graphical representations accessible to all student to experience earlier and easier,” (Kaput & Roschelle, 1997). Mathworlds proved to be successful in small scale classroom studies and needed to be tested on a larger scale (Nickerson et al., 2000; Roschelle et al., 2007; Stroup 2004; Vahey et al., 2004).

The Scaling-Up SimCalc Project was a controlled, randomized experiment to investigate the hypothesis that a wide variety of teachers could successfully implement SimCalc Mathworlds software and curriculum to create opportunities for middle school students to learn more difficult mathematics (Roschelle et al., 2007; Tatar et al., 2007). The 7th grade intervention involved a two to three-week replacement unit curriculum for teaching rate and proportionality students that utilized SimCalc Mathworlds software. The study showed tremendous gains for students across classrooms in the experimental compared to the treatment condition. It revealed that a wide variety of teachers could implement more difficult and conceptually complex mathematics to middle school students to improve students’ mathematics performance. However, there was considerable variation in improvement in both control and treatment groups.

*Hispanic Students and Teachers*

As it happens, the SimCalc study was conducted in Texas and involved a high proportion of Hispanic and White students and teachers. This allows us to investigate student-teacher matching as an explanatory factor for narration in a different context from most of the literature, which is primarily focused on African-American students. Thus, we are positioned to add to the literature by contributing examination of a new group. Additionally, the particular circumstances of Hispanic as compared to White students are of interest. The influx of Hispanic students is a very significant societal trend.

The current study, illustrates the effects of race and ethnicity matching between teacher and student on student math learning by examining a Hispanic community in the context of a focused intervention. The expectation is that this study will help bring policymakers, educators, and researchers of this topic one step closer to resolving the teacher-student matching discourse and improving minority students math achievement. In addition this study will promote establishment of more equitable opportunities for minority students to learn more challenging math with the presentation of math intervention in thus study.

## Research Questions and Hypotheses

This study will seek to answer the following questions and hypotheses:

(1) Does student-teacher racial and ethnic congruence predict student math learning?

*Hypothesis 1:* Students taught by teachers with similar racial and ethnic backgrounds will have higher gains (individual and classroom majority match) in math learning.

(2) Does student-teacher White-White or Hispanic-Hispanic congruence predict student mathematic learning?

*Hypothesis* 2: Minority (Hispanic) students when compared to White students who are of similar ethnic and racial background as their teacher will have higher math gains.

(3) Does teacher expectations of classroom level performance predict student math learning gains in student-teacher racially and ethnically congruence conditions?

*Hypothesis 3:* There is an additional impact of racial and ethnic congruence above and beyond teacher perceptions/expectations of student performance. That is, under-represented students on average will more likely to score higher in these classrooms.

(4) Does the effect of the SimCalc treatment vary depending on whether the student matches the teacher in race and ethnicity.

*Hypothesis 4:* The effect of the SimCalc treatment will vary depending on whether the student matches the teacher in race and ethnicity.

(5) Does the Simcalc treatment moderate the effects of teacher expectations on minority student's classroom performance when the students ' ethnicity matches or mismatches with their teacher?

*Hypothesis 5:* SimCalc treatment will moderate the effects of teacher perceptions/expectations of minority students' academic performance for Hispanic students who are an ethnic match or mismatch with their teacher.

## Delimitations of the Study

Scaling-Up SimCalc data was chosen to investigate this study. In addition to its many advantages, there are some limitations. The participants in the study were limited to students in grade 7 and their mathematics teachers. The selection of the sample was effectively purposive in that teachers were invited to apply by recruiters who also provided Teacher Professional Development in their districts. Although there was also evidence that the teachers who knew the recruiters better were more likely to respond with an application though we cannot refute the possibility of this effect. This method was not entirely convenience driven in that there was a layer of separation between the goals and needs of the research team and those of the recruitment team. However, random sampling is usually considered the gold standard of recruitment and this was not possible. In general, student background data at the individual level, was reported by students (Lubeinski, 2002); however in this study the teachers reported most of the background data collected on students. Arguably, teacher perception of student ethnicity is more important than actual student ethnicity in the context of ethnic matching; however, we have no comparable measure of student perception of teacher ethnicity. The teachers also reported most of the background data collected on them, possibly allowing error due to social desirability factors or memory problems. Many constructs used in the current examination had to be created from existing questionnaire items not designed to measure matching.

Of these delimitations, only possible bias in the subject pool towards those teachers willing to participate suggests a systematic bias that would affect matching hypotheses. However, willingness to participate in a study about technology for mathematics education suggests that participating teachers see themselves and their practices as, at least in some sense open for scrutiny, and that any effects of matching would be diminished.

## Limitations of the Study

Limitations in the study include the scope and the nature of the information that will be available for analysis. The following caveats should be considered when interpreting the results of this study:

1. The study is limited to middle school students in Texas. Generalizability of the results may be limited to similar populations of middle school students.
2. The study contrasts matching in only two ethnic groups: Hispanic vs. White matching and non-matching. Because these are such important groups and conditions, focus on them can be considered strength of the study as well as a limitation, but there is no contrast with the African-American population that has been the subject of much prior work. Findings may not generalize to the African-American-White contrast.

3. Furthermore, the Hispanic population in the United States is complex; we have no constructive measure of the internal composition of our sample.

## Significance of the Study

This study is significant in several ways. Its primary impact should be on our understanding of how to better serve minority children in the public school system. It may influence policy at all levels from national down to the local. It will provide fodder for further argumentation in the courts. If the hypotheses are accepted, it may affect policies pertaining to training minority teachers and may influence the minority teacher's sense of purpose in entering into teaching. It will also help policymakers move towards a more equitable ratio of minority teachers to the minority population in their districts. It may also lead to refinements in our training of majority teachers and more professional development oriented towards compensating in those cases in which a match cannot be attained. The more that we can attend to the needs of our most vulnerable populations, the more the burdened public school system will be able to attend to the needs of all students, and the more educated our society will be as whole.

If the hypotheses remain rejected, then a different kind of dialogue will ensue. Perhaps no metric as simple as matching fully captures the complex relationships of the classroom. Perhaps matching is particularly important in the African-American community or that matching could not be shown to have an effect within the power limits of this particular sample and design. These questions are important to policy makers, school administrators and teachers.

Finally, the present study also has significance for future research. There are several unexplored areas in the area of teacher-student matching. This study will investigate the differences in math performance of those students in the teacher-student match classrooms and those students who are not in the classrooms where teacher and student match by race, ethnicity, and language. Future studies could examine the relationship between teacher-student matching and other important variables, such as socioeconomic status, school type, parental involvement, student engagement, and school tracking. Mathematics was the object of change in this study but future studies might include other academic areas of concern such as reading and science. The current perspective may also influence the analysis of data stemming from other scaling up projects, and focus in the conduct of observational studies.

## Definition and Operational Terms

The following terms and definitions are provided to clarify constructs used in the study:

*Race* is categorized as the difference between American Indian/Alaskan Native, Asian/Pacific Islander, Black, and White (Anderson & Fienberg, 2000).

*Ethnicity* is categorized as either of Hispanic or not of Hispanic origin (Anderson & Fienberg, 2000).

*Race/ethnicity* is categorized as American Indian/Alaskan Native, Asian/Pacific Islander, Black, not of Hispanic origin, Hispanic, and White, not of Hispanic origin, if the data is collected in a combined format (Anderson & Fienberg, 2000).

*American Indian or Alaskan Native* refers to people who trace their origins to North America and maintain cultural identification through tribal affiliations or community recognition (Anderson & Fienberg, 2000).

*Asian or Pacific Islander* are people who trace their origins to the Far East, Southeast Asia, the Indian sub-continent, or the Pacific Islands: for example China, India, Japan, Korea, Philippine Islands, and Samoa (Anderson & Fienberg, 2000).

*Black* are people who trace their origins to any black racial groups in Africa (Anderson & Fienberg, 2000).

*Hispanic* are people of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race (Anderson & Fienberg, 2000).

*White* are people who trace their origins to any of the original peoples of Europe, North Africa, or the Middle East (Anderson & Fienberg, 2000).

*Culture* is "a particular way of life that includes knowledge, values, artifacts, beliefs, and other aspects of human endeavor peculiar to any group or groups of people" (Ladson-Billings, p. 51).

*Cultural* “refers to a variety of humans groupings: race, ethnicity, gender, social class, ability, sexuality, and religion” (Ladson-Billings, p. 53).

*English as a Second Language (ESL) (Student Profile)* is the percentage of limited English proficient (LEP) students participating in an English language development program including intensive English instruction in all subjects, focusing on the language arts through the use of English as a Second Language methodology ("PEIMS Teacher Master," 2005-2006).

*English Language Learners (ELL)* refers to the same as percentage of limited English proficient (LEP) as defined by the government under the No Child Left Behind legislation (NCLB) ("PEIMS Teacher Master," 2005-2006).

*Public Education Information Management System (PEIMS):* PEIMS is a statewide data collection and reporting system operated by the Texas Education Agency. It includes extensive information on students, staffing, and school budget/finances, and serves as the fundamental database for many statewide reports on public education, such as the Academic Excellence Indicator System ("PEIMS Teacher Master," 2005-2006).

*Race and Ethncity Match* refers to when a student is of the same race and/or ethnicity as his or her teacher.

*Classroom Majority Match* exists when the majority of the students in a given classroom by race and/or ethnicity are the same as the teacher of the classroom.

*Race/Ethnicity (Student Profile)* is the percentages of ethnic/racial composition of the student population enrolled at the school as of the last Friday in October for each of the years reported ("PEIMS Teacher Master," 2005-2006).

*The five categories required by the Texas Education Agency and used in the Profiles are:*

African American (not of Hispanic origin), Asian (Asian or Pacific Islander), Hispanic Native American (includes Alaskan), and White (not of Hispanic origin).

*Race/Ethnicity (Teacher Profile)* is the percentages represent the ethnic/ racial composition of the teaching faculty employed ("PEIMS Teacher Master," 2005-2006).

*Race* typically is the assumption of biological differences in physical appearances. It also has a social connation of stereotyping. It suggests one status in the social system

*At-risk student* are those students who has fallen behind in academic performance in reading and language (Slavin, 1991).

*Minority students* include all groups except White students, particularly Hispanic and Black students (U.S. Department of Education, 2006; National Center for Education Statistics, 2007).

$M_1$ *Math Gains* are the student gain scores on 11 test items that measure rate and proportionality as covered in traditional curriculum (Roschelle, et al., 2007).

$M_2$ *Math Gains* are the student gain scores on 19 test items that measure rate and proportionality beyond the traditional curriculum ((Roschelle, et al., 2007).

CHAPTER THREE

DISSERTATION MANUSCRIPT

# The Effects of Teacher-Student Racial and Ethnic Congruence on Student Math Learning: Race Still Matters

(ABSTRACT)

There has been increased attention given to the underlying concerns of educational inequalities related to matters of race (Jost, Whitefield, & Jost, 2005). Race related matters, particularly in public education, have been heavily debated at the national level. Recently, the Supreme Court ruled that assigning students to schools and classrooms based on racial identity is unconstitutional. Researchers have investigated the extent to which teacher race/ethnicity variability has affected minority student academic performance in public schools. Over the years, there has been a great deal of discussion in the literature about matching teacher and student by race and ethnicity. Some people claim that matching is crucial for student success while others dispute this claim. The crux of this analysis is a match/mismatch between aggregated and individual teacher and student characteristics on student learning gains. We gathered data in the context of a successful focused, large-scale randomized, controlled experiment of middle school mathematics learning that contrasted a curricular unit using SimCalc Mathworlds curriculum and a TEXTEAMS control. Performance data from the 92 7$^{th}$ grade mathematics teachers in several regions of Texas and 1576 of their students across 76 school campuses throughout 8 Texas regions were examined to investigate the main effect of teacher-student racial/ethnic congruence in the classroom setting. Hierarchical Linear Modeling (HLM) analysis was used to investigate the differences in student mathematics performance, modeled as students nested in classrooms nested in schools. This study revealed that when teacher and student are of the same racial and ethnic group students academic performance improves, however, not particularly any differently for minority students than for their White counterparts. In fact, the effects of student-teacher racial and ethnic matching can be fully explained by the effects of student race alone. Additionally, there appears to be evidence suggestive that there maybe more embedded complex differences in racial and ethnic groups that have serious implications for comparisons and generalizability between and within these minority groups.

*The Effects of Teacher-Student Racial, Ethnic Congruence on Student Math Learning: Race Still Matters*

There has been increased attention given to the underlying concerns of educational inequalities related to matters of race (Jost, Whitefield, & Jost, 2005). Race related matters, particularly in public education, have been heavily debated at the national level. Recently, the Supreme Court ruled that assigning students to schools and classrooms based on racial identity is unconstitutional (*Parents Involved in Community Schools v. Seattle School District* and *Meredith v. Jefferson County Board of Education*), despite the fact that many studies have shown that race plays a major role in student-teacher interaction (Alexander, Entwisle, & Thompson, 1987; Ainsworth-Darnell, & Downey, 1998; Brewer, Ehrenberg & Goldhaber, 1994; Dee, 2004; Downey & Pribesh, 2004; Farkas et al., 1990; Ferguson, 2003; Irvine, 1986; Oates, 2003) and the persistent racial disparities in the White-Minority achievement gap (Delgado, 2001; Jost, Whitefield, & Jost, 2005; Taylor, 2000). However, the courts have left the door open for further and different rulings. If researchers are able to show that lack of consideration of race has deleterious effects on closing the White-Minority achievement gap and federally mandated programs and initiatives, the ruling may be modified or opened up to specific circumstances. Among its many consequences, this ruling brings into focus the question of student-teacher matching in classrooms. Some researchers and educators claim that matching is crucial for student success while others dispute this claim. Additionally some scholars claim that race should not be considered when organizing or evaluating the classroom and therefore, matching should not even be considered. Others are willing to consider matching, but disagree about whether it is effective or not (Oates, 2003; Muller, 1998).

Several reasons have been given for the importance of a match between students and teacher by race and ethnicity. First, the blatantly obvious racial inequalities that perpetuate the White-Minority achievement gap is growing (Delgado, 2001; Jost, Whitefield, & Jost, 2005; Taylor, 2000) in this country more particularly in public education (Ladson-Billings & Tate, 1995; Ladson-Billings, 2004; Stovall, 2006; Tatum, 1995) as evidenced by racial disparities in student outcome measures (Balfanz & Byrnes, 2006; Mertens & Flowers, 2003; Jamar & Pitts, 2005; Jost, Whitefield, & Jost, 2005). More specifically, the middle school mathematics achievement gap continues to widen and minority students continue to lack opportunities to learn more rigorous and complex mathematics at such a pivotal point in their educational path (Kaput & Roschelle, 1996; Schmidt et al., 2001; Suter, 2002; Tatar et al., 2007). Second, there is a considerable lack of racial and ethnic diversity in teachers (Ladson-Billings, 2004; White-Clark, 2005; Oates, 2003). They are predominately increasingly White, while the public school student population is increasingly Minority (National Center for Educational Statistics, 2003a). Third, teachers are inadequately prepared to teach in a culturally responsive classroom environment and lack a more culturally sensitive curriculum needed in the classroom (Jost, Whitefield, & Jost, 2005; Ladson-Billings, 2004; White-Clark, 2005). Pedagogy should be culturally responsive to build an "intimate connection between knowledge considered basic to any school curriculum and knowledge that is the fruit of the lived experiences of these students as individuals" (Paulo, 1998). Yet, research shows that only 17% of public school teachers believe that they were adequately prepared to teach culturally and linguistically diverse student populations (White-Clark, 2005).

Fourth, the absence of matching (minority students being taught by White teachers not minority teachers) contributes to the negative racial ideologies and subsequent stereotyping of minority students who have reportedly been notably receptive to the teachers perceptions and expectations of their performance (Jost, Whitefield, & Jost, 2005; Oates, 2003). More specifically, the teachers' low expectations of Hispanic and African-American students (Jamar & Pitts, 2005) has been shown to negatively impact the students academic performance in math, science, and reading (Oates, 2003). More subtly, Oates (2003) suggests that that the match between teacher and students shapes teacher perceptions of student performance. Some studies suggest that White teachers view White students as being more academically engaged than Black students (Downey & Pribesh, 2004; Ferguson, 2003). Other studies indicate that White teachers give Black students lower evaluations than Black teachers tend to give them (Alexander, Entwisle, & Thompson, 1987; Brewer, Ehrenberg & Goldhaber, 1994; Downey & Pribesh, 2004; Ferguson, 2003). In these studies researchers assessed White teachers showing bias against Black students through their low expectations of this particular group when their expectations were compared to Black teachers rating of these same students.

Negative racial ideologies, perceptual biases, and subsequent stereotyping are racial tensions that impede student learning and also perpetuate issues of race and racism in the classroom and therefore should be included in any discussion on race matters in the classroom, particularly racial matching. Omini and Winant (1986) define racial ideologies as social constructs and pre-existing beliefs developed about a particular ethnic group that are typically negative and/or inconsistent with the individual members of that group. For example, White is right or Black is bad. Racial ideological theorists contend that careful attention must be placed on the influence of racial ideologies in the classroom to understand its influences on the teacher-student interaction. Racial ideologies and perceptual biases based on assumptions of students' intellectual inferiority that have been argued as one of the leading contributing factors reported by minority student populations that hinder their academic success (Cammarota, 2006). Subsequent negative racial stereotyping by the teachers in the classroom particularly has deleterious effects on individual minority students' performance (Cammarota, 2006). For example, the labeling of minority students as "intellectually inferior" is a racial stereotype about Black and Hispanic students. Despite the demonstrated academic ability of Hispanic and Black students, they are depicted through negative imagery as people of color who are inferior to White students. The teacher is believed to be guided by racial stereotypes and ideologies whether he or she is aware of it or not.

If race plays out in the educational experiences of these minority students in many different ways, then race really matters in minority student performance. Yet, there is a lack of research focused on how teacher race and ethnicity variability impacts minority student performance (Oates, 2003; Brewer, Ehrenberg & Goldhaber, 1994). Unfortunately, there is very little evidence on whether the match, or lack thereof, of teachers and students by race, ethnicity, and gender influences how well students perform. A literature search yielded several studies that explored racial congruence between teacher and students in P-12 education (Alexander, Entwisle, & Thompson, 1987; Ainsworth-Darnell, & Downey, 1998; Brewer, Ehrenberg, & Goldhaber, 1994; Carels, Gray-Little, 1997; Crosnoe & Johnson, 2004; Dee, 2004; Downey & Pribesh, 2004; Farkas, Grobe, Sheehan, & Shuan, 1990; Ferguson, 2003; Irvine, 1986; Oates, 2003; Piggott & Cowen, 2000) however, finding conflict as some studies clearly support the claim that teacher-student racial matching positively affects student performance while others argue definitively that it does not matter and so the question remains "Does race matter?", if so, "How", and more importantly, "What can bring about positive change in this regard?".

*Race and Ethnicity: Race Matters in the Classroom*

The purpose of this study was to investigate the effects of teacher and student matching by race and ethnicity on careful predications of middle school students' math learning gains. Race and ethnicity share some commonalities in meaning and in some instances these terms can be defined as two completely different constructs that have become fundamentally controversial and confusing in the United States (Anderson & Fienberg, 2000; Williams & Collins, 1995). Race and ethnicity are typically defined in terms of "shared genealogy which is identifying ancestral or descendant families through the use of historical records to establish biological, genetic, or familial kinship; tracing family lineages and history" (Williams & Collins, 1995). However, ethnicity is a broader category that also connotes shared cultural, linguistic, behavioral or religious traits, and migration and nationality. For instance, for reporting purposes, the United States federal government defines the *Ethnicity* categorization as either of Hispanic or not of Hispanic origin and by these standards Hispanics are the only group members in this category (Anderson & Fienberg, 2000). According to the Office Management and Budgeting (Anderson & Fienberg, 2000), *Race/ethnicity* is categorized as American Indian/Alaskan Native, Asian/Pacific Islander, Black, not of Hispanic origin, Hispanic, and White, not of Hispanic origin, if the data is collected in a combined format (Anderson & Fienberg, 2000). This method for collecting and reporting race and ethnicity data is the most widely used in educational settings as such, the public school data used in this study was collected and reported using this prescribed federal format.

On the other hand, race can be defined by three schools of thought including the federal government's definition: (1) biological lineage (Anderson & Fienberg, 2005), (2) socially constructed beliefs that refer to race as a social location that disadvantages minority group members relative to Whites (Ogbu, 1998; Williams & Collins, 1995), and (3) the situational meaning of race (Omini & Winant, 1986). In this study it is important to understand that all these dimensions of race whether independent or not shape our views about race, racism, issues of race identity, the impact of race on society as a whole, and by extension race still matters in the classroom.

*Theoretical Framework: Critical Race Theory in Education*

The current study examined the question of ethnic and racial matching empirically in the context of a large-scale randomized controlled study of an innovation for middle school mathematics learners. In order to explain why race matters in public education, frame the discussion of our findings, define and justify race and ethnic related problems, and address issues of racial matters in the classroom as evidenced by racial disparities in the classroom, I draw upon selected tenets of the Critical Race Theory (CRT). Additionally, CRT is used to frame the discussion and explanation that the explanation of racial matching may provoke on how race and racism shapes the educational experiences, social practices, cultural beliefs and teacher's practices in public school (Delgado, 2001). CRT was developed in the 1970's by scholars and activists such as Derrick Bell, Alan Freeman, and Richard Delgado and primarily focused on issues of race, racism, and racial inequalities in the justice system (Delgado, 2001; Ladson-Billings, 2004; Taylor, 2000).

Critical race theory is founded on several assumptions to consider for this study: (1) issues of race and racism are endemic in American society including classrooms (Delgado, 2001; Ladson-Billings, 2004; Taylor, 2000), (2) dominant legal claims of neutrality, objectivity, colorblindness, and meritocracy inherent in public education. Those who do not recognize the problem are perpetuating racial issues and racism therefore color continues to matter....race matters in our classrooms, schools, and society, (3) race related and racist structures have operated in schooling in order to provide White advantage to the disadvantage of minorities, (4) racism has contributed to all contemporary manifestations of group advantage and disadvantage, and (5) research should work towards the end of eliminating racial oppression as part of a broader goal of ending all forms of oppression.

Ladson-Billings & Tate (1995) extended the use of the critical race theory beyond its implications in the justice system to shed light on racial equalities in education. They challenge scholars to apply the critical race theory to school practices including "institutional discriminatory mechanisms and racial ideologies that forgo race and racism in education." Furthermore, Ladson-Billings and Tate, (1995), Tatum, (1995), and Stovall (2006) believe that utilizing tenets of critical race theory can help educational researchers facilitate understanding of the systemic educational structures still in place that operate to impede equality of educational opportunity for *all* children, as well as challenge the traditional curricular structures, processes, and discourses that continue to marginalize students of color (Yosso, 2002). Matching teacher and student by race and ethnicity should enlighten and provide deeper discussion and meaning of how teachers' engagement, approach, perceptions, expectations, racial stereotypes and attitudes affect student achievement.

CRT theorists emphasize that race still matters and the social construction of race has complicated the vast majority of minority student learning in public school classrooms across this country in both overt and subtle ways. Racial and ethnic congruence conditions are particularly relevant to the importance of race in the context of educational inequalities (Ladson-Billings & Tate, 1995) in student achievement. Investigating teacher and student racial matching provided a deeper understanding of the inequities in schooling and society.

Simply stated according to the critical race theory, race continues to be a poorly understood construct, a complex phenomenon with ill-defined categories that overlap with class, identity, ethnicity, and culture (Ladson-Billings & Tate, 1995; Omi & Winant, 2005; Taylor, 2006), and evidenced by the social-historical construction of the African-American and Hispanic race in U.S. society as well as by slavery statutes, and Supreme Court decisions.

### *Racial and Ethnic Congruence Literature*

There is a growing body of literature specifically addressing racial matching between teachers and students. Since the mid 1980's researchers have been exploring racial congruence in national, state, and school wide data sets on teachers and students. Drawing on data from the second and third wave of the National Educational Longitudinal Study (NELS) 1988 when the students were in the $10^{th}$ and $12^{th}$ grade, Oates (2003) concluded that the impact of racial congruence on teacher perceptions was "noteworthy" for African-American students test performance but not so "notable" for their White counterparts. Contradictory studies say that racial matching does not predict student achievement with a few exceptions. Working from the first wave of NELS 1988 data, Brewer concluded that teacher characteristics do not influence how much students learned between $8^{th}$ and $10^{th}$ grade in reading, math, history, and science. However, teachers' perceptions of their students reflected in the "tracking" and "encouraging" of their students. Black male students had higher test gain scores in history when taught by Black male teachers than their White counterparts. Also noteworthy, Black female science teachers were associated with higher science scores for Hispanic and White female science students. Brewer et al., 1994) discuss how

> In comparison to White male teachers, Black male teachers are associated with higher history gain scores for Black male, White male and White female students, but lower reading scores for Hispanic male students. Black female science teachers are associated with higher science scores for Hispanic female and White female science students. White female teachers are associated with lower reading and history scores for Hispanic male students, but higher science scores for Hispanic female students. Finally, quite strikingly, there is no evidence that, as compared to White male teachers, White female teachers increase, or decrease, the scores of their White male or female students in any subject, (p. 10).

Pigott & Cowen (2000) found that teacher student racial congruence did not predict any differences between black and White students in a study in Rochester public school system. Oates (2003), Brewer et al. (1994), and Pigott & Cowen (2000) revealed that White students almost exclusively had White teachers while Black & Hispanic students had primarily White teachers but their studies yielded different results. For instance, Brewer et al., (1994) noted

> As compared to White male teachers, Black male teachers are associated with significantly higher subjective evaluations for Black male students in reading and science and for Black female students in mathematics and science. Hispanic teachers of either gender are associated with significantly higher subjective evaluations for Hispanic students of either gender in mathematics, (p. 12)

The mixed literature supports the need for further investigation in the area of racial congruence.

### *Minority Student Mathematics Performance*

Research on mathematics performance among United States high school and middle school students shows that their performance lags behind that of many developed countries (Balfanz & Byrnes, 2006; Kaput & Roschelle, 1996; National Council of Teachers of Mathematics, 2000). One disproportionately affected group is minority students, particularly African-American and Hispanic who perform on the average 45 points (see Table 2.1) below their White counterparts on the $8^{th}$ grade National Assessment of Educational Progress (NAEP) examination (Balfanz & Byrnes, 2006; Mertens & Flowers, 2003; Jamar & Pitts, 2005). This low performance amongst minority students is a cause for concern for policy-makers, researchers, and educators, as well as the general public.

Research has linked minority students' mathematics performance to several factors including socioeconomic status (Mertens & Flowers, 2003; Lubienski & Lubienski, 2005; McGraw et al., 2006), family attributes, cognitive and affective characteristics, school environment factors, equitable opportunities to learn more rigorous mathematics (Jamar & Pitts, 2005; Roschelle & Kaput, 1996), teacher classroom practices, behaviors, attitude (Mertens & Flowers, 2003; Glass, 2000), and under-motivated students and teachers (Cammarota, 2006). It has also linked minority student mathematics performance to racial and ethnic differences between teacher and students (Downey & Pribesh, 2004; Oates, 2003), and to a lack of understanding of English language learners (Minami & Ovando, 2002).

Table 2.0

*NAEP National Mathematics Results for Grade 8 - Public Schools, Percentages of Students Below, at or above Achievement Levels, By Race/Ethnicity, 2000*

| | | | Achievement Level | | | |
|---|---|---|---|---|---|---|
| Race/Ethnicity | N | Average Scale Score | Advanced | Proficient | Basic | Below Basic |
| White | 4988 | 285 | 6% | 34% | 77% | 23% |
| Black | 1854 | 246 | 0% | 5% | 32% | 68% |
| Hispanic | 1909 | 252 | 1% | 9% | 40% | 60% |
| Asian/Pacific Islander | 451 | 288 | 11% | 40% | 75% | 25% |
| American Indian | 133 | 261 | 0% | 12% | 50% | 50% |

*From the National Assessment of Educational Progress ("The Nation's Report Card"). Copyright, 2000 of the National Center for Educational Statistics, Permission of U.S. Department of Education, Public domain

Some researchers view the problem as centrally located in the preparation of students at the middle school level (Anfara & Lipka, 2003). The achievement gap has been consistently reported to develop most rapidly between 5th and 8th grade (Balfanz & Byrnes, 2006). Whether it originates in middle school or not, it carries over from middle to high school, from high school to college and from either and/or both high-school and college to future employment prospects. The gap in performance is related not only to individual students, but also to the level of classroom performance. Nearly 67% of Black students and 73% of Hispanic students are found in schools where at least 50% of the student population is comprised of minority students (Orfield & Yun, 1999). Yet, in many cases, almost all of their teachers are White (HR Exchange, 2004), and as research (Oates, 2003; Jost, Whitefield, & Jost, 2005) suggest classrooms predominately populated by African-American students matched with a White teacher tend to have lower levels of achievement. Because of this disparity of minority performance in classrooms led by White teachers, Kailin (1999), observes that

> because nearly 90 percent of the teaching force in the United States is White at a time when children of color will soon compromise the majority of students in public education, it is imperative that we examine teachers' views about how racism is manifested in their schools, [because] the way school desegregation has been implemented, there has not been real integration in education, (p. 725)

Consequently, as research suggests, it is important to gain an understanding of how racial matching between teacher and student may impact minority student achievement so that policy making entities such as the Supreme Court can make more informed decisions regarding matters of race in public schools. Although strong claims for the importance of matching have been made, they have not been sufficient to persuade everyone, especially not the Supreme Court. Furthermore, middle school mathematics provides a particularly important arena for exploration because of its high impact on future life prospects for students. Although the larger study in which the data set was gathered focused on changes in curriculum, especially with respect to technology-use, the National Council of Teachers of Mathematics (2000) has claimed that one of the strongest links in the development of mathematical skill is the mathematics teacher. I explored the role of the mathematics teachers via the issue of matching. Further causal exploration of the teacher's role and the importance of matching conducted by the inclusion of data about teachers' expectations, perceptions, attitudinal variables, and classroom practices, all or some of which have been claimed as important factors in the classroom and mediating variables in the impact of racial matching (Oberlander & Talbert-Johnson, 2004). The racial matching literature suggests that I will find in the correct data superior performance for students and classrooms in which racial/ethnic matching obtains as compared to those for which it does not. The position of Hispanic learners in the United States further the literaterature in racial matching in the African-American community suggests that they are similar effects will be found for Hispanic matching as for African-Americans.

*Contextual Background: Simcalc Mathworlds and Math Performance*

It has been long suggested that the reason US math performance begins to lag behind in middle school is due to the lack of opportunity for students to learn rigorous, complex and conceptually difficult mathematics (Kaput & Roschelle, 1997; Schmidt et al., 2001; Suter, 2002; & Tatar et al., 2007). SimCalc Mathworlds (www.simcalc.umassd.edu) is an innovative curriculum and software designed to introduce middle school students to more rigorous and conceptually difficult mathematics. The description of change and variation are crucial elements in such mathematics. SimCalc Mathworlds aims "to enable all children to learn the mathematics of change beginning in early grades" (Kaput & Roschelle, 1997). SimCalc Mathworlds lays the foundation for calculus through the use of a pedagogy utilizing representations that allow active engagement with representations of change and variation through graphs, tables, and simulations as well as algebriac expressions (Hedges & Lesh, 2008). The researchers designed the curriculum to emphasize the tie between motion phenomena and the representation in graphical forms by tying aspects of the representations together actively using drag-and-drop techniques and by allowing animation of the phenomena and manipulation of piece wise defined for others in addition to continuous areas (Kaput & Roschelle, 1997). Mathworlds proved to be successful in numerous small scale classroom studies and needed to be tested on a larger scale (Nickerson et al., 2000; Roschelle et al., 2007; Stroup, 2004; Vahey et al., 2004).

The Scaling-Up SimCalc Project was a series of controlled, randomized experiment to investigate the hypothesis that a wide variety of teachers could successfully implement SimCalc Mathworlds software and curriculum to create opportunities for middle school students to learn more difficult mathematics (Roschelle, 2005; Tatar et al., 2007). The first year of the first study, a 7$^{th}$ grade intervention, involved a two to three-week replacement unit curriculum for teaching rate and proportionality students that utilized SimCalc Mathworlds software. The study showed tremendous gains in mathematics performance for students across classrooms in the experimental compared to the treatment condition. It revealed that a wide variety of teachers could implement more difficult and conceptually complex mathematics to middle school students to improve students' mathematics performance.

*Hispanics and Schooling*

The minority teachers and most of the minority students in this sample were Hispanic. Hispanics are the fastest growing minority (Amaro & Zambrana, 2000; Waters, 2000) and are projected to become the largest minority group in the United States by 2010. They are highly concentrated in five states: California (33%), Florida (6%), New York (11%), Illinois (5%), and Texas (21%). Unfortunately, Hispanic students have the highest rate of school failure of any other minority group in the nation (Valdivieso & Siobhan, 1992). They generally score lower than White students in math, science, and reading (Battle & Pastrana, 2007). Many Hispanic students enter high school with reading levels below their grade and further behind in math than their White counterparts (Cammarota, 2006), and are more likely to drop out as shown in figure 2.2, and less likely to attend college than their White and Black counterparts (Amaro & Zambrana, 2000; Aspey & Sanchez, 2005; Cammarota, 2006; Oakes, Joseph, & Muir, 2004; Valdivieso & Siobhan, 1992). Additionally, many of the Hispanic students who do remain in school are considered "at-risk" of dropping out as a result of having low grades and poor attendance (Aspey & Sanchez, 2005). The problem has been linked to segregation (Cammarota, 2006), poverty (Oakes, Joseph & Muir, 2004), language issues (Minamo & Avando, 2004), cultural differences, school policies, teachers' negative stereotyping, teachers' lack of cultural competence, teachers' inadequate training for the multi-cultural and multi-lingual classroom setting, race related issues.

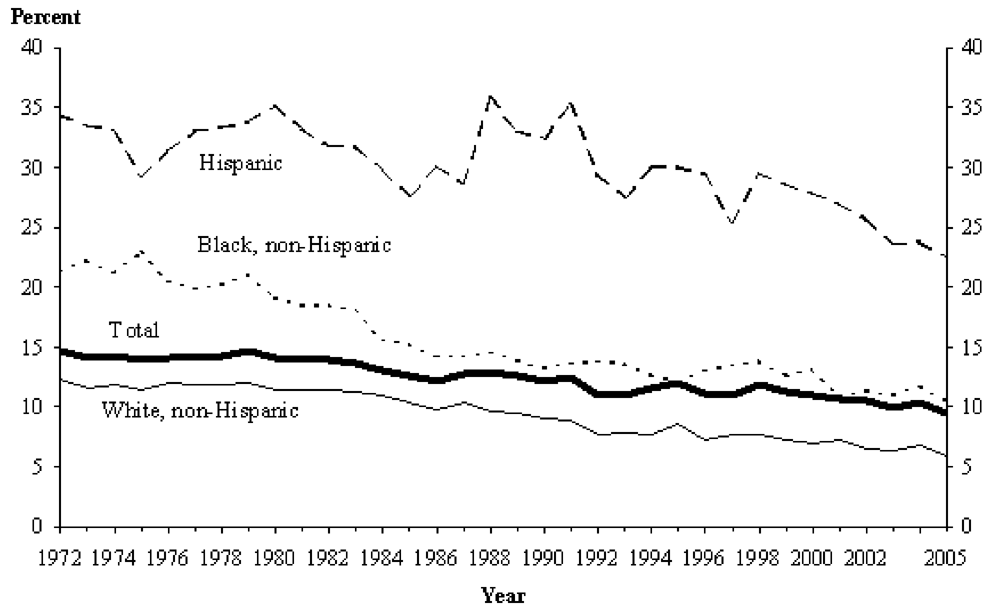


*Figure 2.2.* Status dropout rates of 16- through 24-year-olds, by race/ethnicity: October 1972 through October 2005.

NOTE: The status dropout rate indicates the percentage of 16– through 24–year–olds who are not enrolled in high school and who lack a high school diploma or equivalent credential such as a General Educational Development (GED). Beginning in 2003, respondents were able to identify themselves as being more than one race. The 2003 through 2005 categories for White, non– Hispanic and Black, non–Hispanic contain only respondents who indicated just one race. The Hispanic category includes Hispanics of all races and racial combinations. Because of small sample size for some or all of the years shown in the figure, American Indians/Alaska Natives and Asian/Pacific Islanders are included the totals but not shown separately. The "more than one race" category is also included in the total in 2003 and 2004 but not shown separately because of small sample size. The variable nature of the Hispanic status rates reflects, in part, the small sample size of Hispanics in the CPS. Estimates beginning with 1987 reflect new editing procedures for cases with missing data on school enrollment items. Estimates beginning with 1992 reflect new wording of the educational attainment item. Estimates beginning with 1994 reflect changes due to newly instituted computer–assisted interviewing. For details about changes in CPS over time, please see Kaufman, Alt, and Chapman (2004).

*Source: U.S. Department of Commerce, Census Bureau, Current Population Survey (CPS), October (1972–2005). Permission of U.S. Department of Education, Public domain

As it happens, the SimCalc study was conducted in Texas and involved a high proportion of Hispanic and White students and teachers. This allowed us to investigate matching in a different context from most of the literature, which is primarily focused on African-American minorities. Thus, we were positioned to add to the literature by contributing examination of a new group. The particular circumstances of Hispanic as compared to White students are of notable interest as the Whites outperform the Hispanic 4 to 1.

## Research Questions

Based on this literature the current paper investigates the following research questions:

(1) Does student-teacher racial and ethnic congruence predict student (individual and classroom majority match) math gains?

(2) Does student-teacher White-White or Hispanic-Hispanic congruence predict student mathematic learning?

(3) Do teacher expectations of classroom level performance predict student math learning gains in student-teacher racially and ethnically congruence conditions?

(4) Does the SimCalc treatment effect vary depending on whether the student matches the teacher in race and ethnicity?

(5) Does the Simcalc treatment moderate the effects of teacher expectations on minority students' classroom performance when the students ethnicity is a match or mismatch with their teacher?

### *Simcalc Scaling Up Dataset*

The goal of the SimCalc Scaling-Up project was to examine whether a wide variety of teachers and students can benefit from the use of SimCalc Mathworlds curriculum and technology. The project's approach was to conduct several large, controlled, randomized experiments. The full-longitudinal design involves several years and studies in both 7$^{th}$ and 8$^{th}$ grade classrooms. The current study, however, focuses on the data gathered in the first full year of the 7$^{th}$ grade study. Figure 2.3 outlines the experimental procedure, teachers completed the first year of the study from various regions in Texas. As illustrated in Table 2.1, the experiment involved random assignment by school of teachers into one of two major design conditions:

(1) In the experimental, or treatment group, teachers were asked to teach rate and proportionality to a randomly assigned target class using a 2-3 week long replacement unit of SimCalc technology and curriculum. To do this, they participated in a professional development workshop on rate and proportionality, a second workshop on teaching the particular curriculum and technology, and a planning weekend,

(2) In the control (really a delayed treatment group), or control group, teachers received professional development on rate and proportionality but did not use SimCalc curriculum and software (see figure 2.1) or receive training in them.

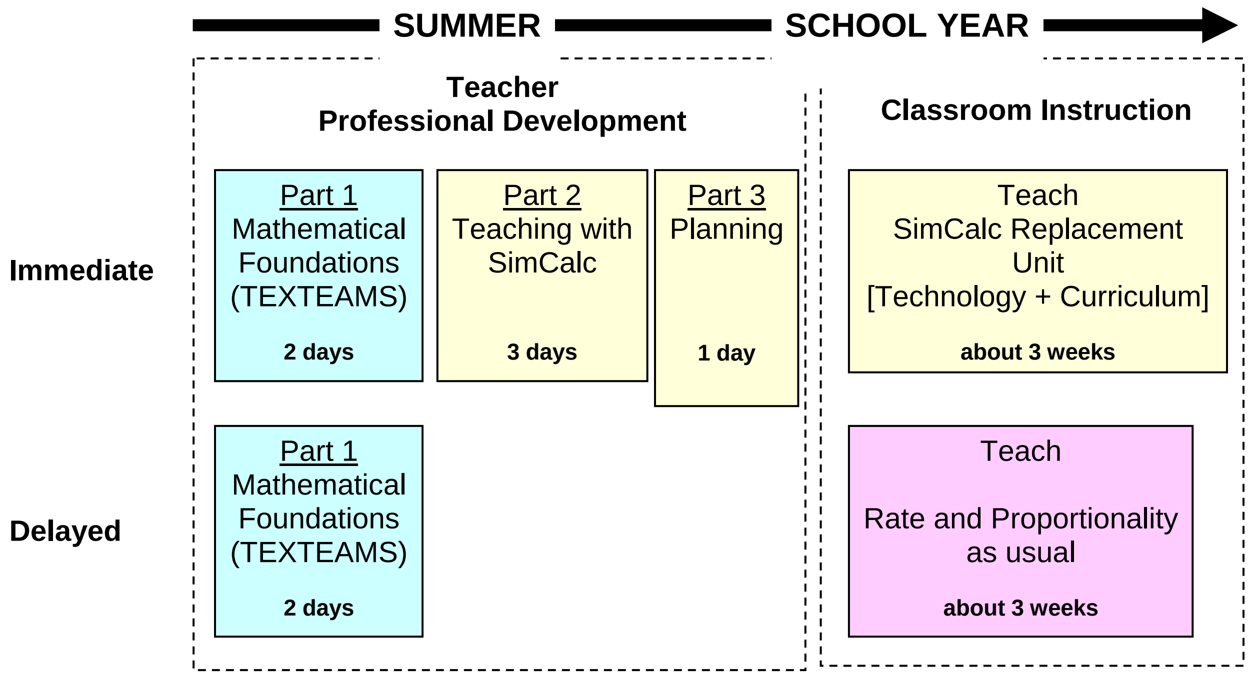


*Figure 2.3. Outline of experimental procedure for year one, 7th grade.*

The students under both conditions were administered the same pre and post test on rate and proportionality. The assessment distinguished between "basic" or "business" as usual items and more advanced mathematics. The intervention shows that students in the treatment classrooms learned basic mathematics to the same degree as their peers. The students in the treatment classrooms had a significantly higher math gain scores, to include the complex or function-based, portion of the test, than their peers in the control conditions (Roschelle et al., 2007).

Table 2.1

*Experimental Design Approach*

| | Year 1 | | | Year 2 | | |
|---|---|---|---|---|---|---|
| Treatment | $O_1$ | X | $O_2$ | $O_3$ | X | $O_4$ |
| Control | $O_1$ | | $O_2$ | $O_3$ | X | $O_4$ |

## Methods

In this paper I examined the specific hypotheses:

*Hypothesis 1:* Students taught by teachers with similar racial and ethnic backgrounds will have higher gains (individual and classroom majority match) in math learning.

*Hypothesis* 2: Minority (Hispanic) students when compared to White students who are of similar ethnic and racial background as their teacher will have higher math gains.

*Hypothesis 3:* Teacher perceptions/expectations of student performance will be more in alignment with their performance for marginalized students when there is a match of teacher and student by race and ethnicity.

*Hypothesis 4:* The effect of the SimCalc treatment will vary depending on whether the student matches the teacher in race and ethnicity.

*Hypothesis 5:* SimCalc treatment will moderate the effects of teacher perceptions/expectations of minority students' academic performance for Hispanic students with match and mismatch teacher.

### *Teacher-Student Matching Sample*

The study of racial and ethnic teacher-student matching utilized the SimCalc data to develop the variables needed to test and analyze my hypotheses. The sample for the study was 92 teachers as 3 teachers were removed for the current analysis for several reasons: (1) one of the teachers was African-American and the other two were of Asian American descent, and (2) in neither ethnic group was large enough to make any generalizable conclusions about that population.

The sample of 92 teachers of 1,342 students was taken from 73 middle school campuses across 8 regions in Texas: Region 1-Edinburg (18 teachers) , Region 6-Huntsville (6 teachers), Region 9-Witchita Falls (7 teachers), Region 10-Dallas (8 teachers), Region 11-Forthworth (11 teachers), Region 13- Austin (18 teachers), Region 17-Lubbock (2 teachers), and Region 18-

Midland (22 teachers) which is the physically largest Educational Service Center region in Texas. The 7th grade year one sample totaled 47 (48.9%) teachers in the treatment group and 45 (51.1%) in the control group. There were more females than males, at 73 (79.3%) and 19 (19.1%) respectively. The majority of teachers were White 70 (76.1%), and 22 (23.9%) were Hispanic. All of the teachers had earned at least a Bachelor's degree 79 (83.2%) and 16 (16.8%) had continued on to earn a Master's degree. The average age of the teachers was 42 years of age with 10 years of teaching full-time experience.

The student sub-sample consisted of 1342 consists of 790 (50.1%) treatment students and 786 (49.9%) control students. There was a slightly larger portion of male students 744 (47.2%) than female students 732 (46.4%), and 100 (6.3%) of the student gender profiles were missing. Unlike our teacher pool, there were more Hispanic students 696 (44.4%) in our sample than White students 652 (41.4%) while only 66 (4.2%) of the students were African-American and 26 (1.6%) were reported as Asian. The remaining 136 students (8.7%) were labeled either "other" or "missing."

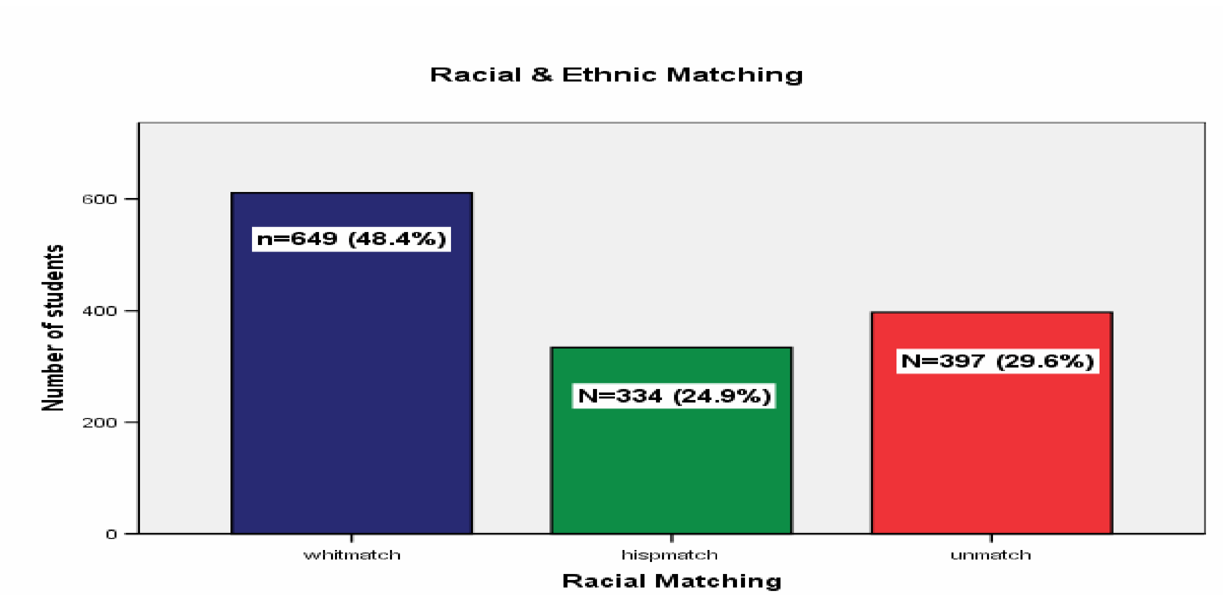


*Figure 2.4.* Teacher-student match sample.

*Development of Predictor Matching Variables*

The match variables discussed in this paper include: race-match and majority class-race match. More specifically, if 50% or more of students in a class were Hispanic and the teacher reported that he or she was also Hispanic that was considered a majority class-race match. The same applies to classroom where the majority of the students in a class were White and the teacher was White. Figure 2.4 illustrates the unequal number of unmatched (29.6%), Hispanic-Hispanic match (24.9%), White-White match (48.4%) students.

### *Instrumentation and Scale Development*

Several instruments were used to collect data on the schools, teachers, and students to include: information sheets, student assessments (pre and post unit), teacher logs (daily, pre and post unit), in-depth classroom observations, post unit telephone interviews, Public Education Information Management System (PEIMS) Texas census data, and student and teacher questionnaires. The data for the current study was mostly drawn from three of the project instruments: (1) Teacher Background Questionnaire, (2) PEIMS Texas census data, and (3) the student assessments (pre and post unit). The full instruments were not used for this study as the data came from part of a larger study.

### *Teacher Background Questionnaire*

The first instrument, the Teacher Background Questionnaire was compiled and adapted for the study. It provided attitude, belief, and background information about the teacher and his or her classroom practices. Following the pilot study results, the Teacher Background Questionnaire was modified and the final instrument resulted in three sections: (1) teacher background and demographic type of questions developed by the project, (2) items adapted from the Teaching, Learning, and Computing (TLC) survey which contains questions about the correlation between teacher pedagogy and their computer use in teaching (Ravitz, Becker, & Wong, 2000), and (3) the Patterns of Adapting Learning (PALS) survey created by Midgley, Maehr, Hruda, Anderman, Anderman, Freeman, Gheen, Kaplan, Kumar, Middleton, Nelson, Roeser, & Urdan.

The first section of the Teacher Background questionnaire included items about the teacher's academic background characteristics, teacher and student languages, and teacher and school related professional practices. In addition, there were 5-items that were used to form a scale to measure teacher expectations. The reliability of the items was .69 Cronbach alpha. The teachers were asked what their expectations ( Table 2.5) were of: (1) the percentage of students that will graduate from high-school, (2) the percentage of students that will mastery of algebra by end of 8th grade, (3) the percentage of students that will master algebra by the end of high-school, (4) the percentage of students that will master calculus be the end of high-school, and (5) percentage of students that will obtain a 4 year degree.

### *PEIMS Texas Census Data*

The second source of data collection was the PEIMS Texas census data which provided additional background data on the teachers, schools, and students. PEIMS manages all data collected Texas Educational Agency (TEA) about public education, personnel, financial, and organizational information in Texas. We draw on the data for comparison purposes to assess distributions of teacher gender, age, race and ethnicity, educational attainment (degree earned), full-time teaching experience in p-12, school size, student eligibility for free and reduced lunch, student ELL enrollment, bilingual enrollment, and student gifted and talented enrollment each by school, district, and region.

### *Student Math Assessments*

The third instrument was the student assessments was a student pre and post student unit test given to the students. The 30-item test was divided into two categories of items: M1 (standard conceptually simple rate and proportionality) and M2 items (complex and conceptually difficult). The pre and post test on rate and proportionality test items were garnered from two sources: (1) the "TAKS", or Texas standards exam, to evaluate students on standard math for their grade, and (2) those developed by the researchers on more advanced topics to include function based (y=kx) questions on rate and proportionality. The standard approach to teaching $7^{th}$ graders is formula based (a/b =c/d). The control and treatment teachers were exposed to the concept of teaching function-based proportionality in the SimCalc professional development (TEXTEAMS) workshop (see Figure 2.3).

Table 2.2

*Student Assessment Reliability*

| Test Items | Number of Items | Cronbach Alpha |
|---|---|---|
| M1 Subscale | 11 | 0.73 |
| M2 Subscale | 19 | 0.82 |
| Whole Test | 30 | 0.86 |

*Hierarchal Linear Modeling (HLM)*

The variables in this study were analyzed using hierarchal linear modelling to build statistical models to investigate the research questions and support the research hypotheses. The research design for the study is illustrated in Figure 2.3. The experimental design relative to this study is in Table 2.1. The researcher views this investigation as examining the relationship between variables residing at different hierarchical levels. In this regard, the appropriate research methodology is Hierarchical Linear Modeling. HLM is an approach that deals with hierarchically nested data structures. By using HLM, the researcher can model explicitly both within and between group variance for students, as well as investigate the influence of the higher level variables, teacher characteristics on the lower level outcomes – student outcomes within a "single analytical framework" (Bryk & Raudenbush, 2002).

The use of HLM also allows researchers to flesh out "the interdependent and hierarchical nature of the multilevel influences on student math gains" (Luke, 2004, p. 3). Ordinary Least Square (OLS) and other individual level statistical tools have been inappropriately used to account for the multilevel nature of models when their data and hypotheses were multilevel in nature (Luke, 2004; Raudenbush & Bryk, 2002). The HLM models allows for "substitution and rearrangement of terms in the model from the different levels to get a single prediction equation sometimes referred to as the mixed-effects model" (Luke, 2004, p. 11). This single analytic model distinctly depicts the specific parts of the model such as the fixed effects, gammas ($\gamma$) and the random effects, the error terms ($e$, $u$ and $r$) and that the level-1 parameters ($\beta_{0j}$, $\beta_{1j}$) which are not directly estimated but are indirectly estimated through the level-2 gammas ($\gamma$).

Research supports the use of HLM multilevel modeling technique in this study for several other reasons: the account for error precisely and appropriately (Luke, 2004), and the use of level-1 intercepts and slopes as outcomes of level-2 and/or level-3 predictors (Hoffman, 2007). Raudenbush & Byrk, 2002) simply stated that, "traditional single-level techniques frequently ignore the fact that student observations within the same school are dependent, which can lead to aggregation bias, misestimated standard errors, and heterogeneity of regression."

The researcher conceptualizes that students were nested within teachers/classrooms nested in schools. The dependent variable in the analysis is student mathematics gain scores measured by the difference between pre and post-unit outcomes. The level-one (L-1) data relates to information on individual seventh graders *(n=1,342)*, level-two (L-2) data is the characteristics of the mathematics teachers -aggregates about the classroom *(n=87)*, and level three (L-3) data is aggregated school *(n=73)* factors.

Table 2.3

*Student Math Outcome Variables at Level-1*

| Variable | Description |
|---|---|
| sa_dif | Student total gain score |
| sa_difm1 | Student M1 gain score |
| sa_difm2 | Student M2 gain score |

*Student Predictor Variables (Level-1)*

The level one predictors of student mathematics attainment are gender (STD_GEND coded 0 for male, 1 for female), and race/ethnicity (STD_RACE coded 0 for White, 1 for Hispanic), experimental conditions (GROUP coded 0 for control classrooms, 1 for treatment classrooms), race-match (RACE_MAT coded 0 for no match, 1 for match), and Hispanic match and White match indicator variables. The dependent or outcome variables of interest at level one in this study are student mathematic gain scores: M1, M2, and total gain scores respectively (SA-DIFM1), (SA-DIFM2), and (SA-DIF).

Table 2.4

*Student Predictor Variables at Level-1*

| Variable | Description | Coding |
|---|---|---|
| group | Experimental Group | Control……………..……..0<br>Treatment……………..…...1 |
| std_gender | Gender (teacher report) | Male………………...…....0<br>Female…………..……...1 |
| std_race | Student Race (teacher report) | White……………...…….0<br>Hispanic……………..…….1 |
| *Matching Predictor Variables* | | |
| race_match | Race Match | Match……………………..1<br>No Match……………..…..0 |
| hisp_match | Hispanic student-Hispanic teacher indicator | Hispanic-Hispanic Match...1<br>White-White Match……....0<br>Unmatched……………….0 |
| white_match | White student-White teacher indicator | White-White Match……....1<br>Hispanic-Hispanic Match...0<br>Unmatched……………….0 |
| no_match | Unmatched student-Unmatched teacher indicator | White-White Match……....0<br>Hispanic-Hispanic Match...0<br>Unmatched……………….1 |
| hisp_race | Hispanic students only indicator | Hispanic Student…………1 |
| stdracw | Student race | White Student …………...1<br>Hispanic Student………....0 |

*Teacher Predictor Variables (Level-2)*

The level-two predictors include teachers gender (TCH_GEND coded 0 for male, 1 for female), race and ethnicity (TCH_RACE coded 0 for White, 1 for Hispanic), experimental conditions (GROUP coded 0 for control teachers, 1 for treatment teachers), teacher regional conditions (REGION), and majority class-teacher race match (CLRACE_M). The continuous variables were teachers age (TCH_AGE), mathematics teaching experience (TCH_MATH), class size (CLASS_SI), full-time teaching experience in k-12 (TCH_EXP), and various teacher perception variables (see Table 2.6).

Table 2.5

*Teacher Predictor Variables at Level-2*

| Variable | Description | Coding |
|---|---|---|
| tch_gend | Teacher Gender | Female……………………...1<br>Male……………………..…….0 |
| tch_exper | Full-time Teaching Experience | |
| group | Experimental group | Treatment……………..…...1<br>Control……………..…….0 |
| tch_age | Teachers Age | |
| tch_race | Teacher Race | Hispanic………………..…...1<br>White…..………………..….0 |
| tch_math | Math Teaching Experience | |
| tchracw | White Teacher race indicator | White Teacher……………1 |
| region | Texas ESC Region | |
| class_si | Class Size | |
| *Teacher-Class Matching Variable at Level-2* | | |
| clrace_match | class_teacher race match | Match…………………...1<br>No Match………………0 |

Table 2.6

*Teacher Expectation Predictor Variables at Level-2*

| Variable | Description |
|---|---|
| exp1 | % of students teacher expects will graduate from high school |
| exp2 | % of students teacher expects will master algebra by end of 8th grade |
| exp3 | % of students teacher expects will master algebra by the end of high school |
| exp4 | % of students teacher expects will master calculus by end of high school |
| exp5 | % of students teacher expects will obtain a 4 year degree |
| tchexpec | teacher expectations of students as a composite of the five items |

*School Predictor Variables (Level-3)*

The level-three predictors include school level variables such as school size (SCHOOL_S), percentage of students eligible for free and reduced lunch by district (SES_DIST) and school (SES_CAMP), percentage of students ELL enrollment (PERCENTE), percentage of students gifted and talented enrollment (PERCENTG), percentage of special education students enrollment (PERCENTS), percentage of students bilingual enrollment (PERCENTB), and the percentage of Black (PERCENAF), Hispanic (PERCENHI), White (PERCENWH), Native Americans (PERCENNA), and Asian (PERCENAS), student enrollment (see Table 2.7) all by school and district. Many of the school level variables ( Dee, 2004; Oates, 2003) in this study have been cited in the literature as compounding explanatory variables affecting student learning gains therefore we statistically removed or controlled for these variables as covariates in our HLM models. This allowed for more precise estimation of the variables of inference.

Table 2.7

*School Predictor Variables at Level-3*

| Variable | Description |
|---|---|
| poverty | Number of students eligible for free or reduced lunch |
| school_size | School Size |
| percenHisp | % Hispanic students |
| percenWhite | % White students |
| percentgift | % Gifted & Talented students |
| percentSpeci | % Special Education students |
| percentELL | % English Language Learner students |

Results

Descriptive statistics including means, standard deviations, minimums, and maximums for the teacher-student match sample are included in Table 2.8, 2.9, and 2.10. Although the initial data set for this analysis was on 1,576 students, 92 teachers, and 76 schools, not all of the data was included in the HLM analysis. Several cases were dropped from the analysis as there was data missing for one or more of the variables and similarly to regression analysis incomplete cases are dropped. For this study, the final sample consists of 1,342 students, who have 87 math teachers, within 73 schools. Although HLM techniques can handle unbalanced designs (e.g., different numbers of students for each teacher), missing data will still be removed before running the analysis.

Table 2.8

*Student Level Descriptive Statistics*

| Variable | N | M | SD | Min. | Max. |
|---|---|---|---|---|---|
| race_mat | 1342 | 0.70 | 0.46 | 0.00 | 1.00 |
| std_race | 1342 | 0.52 | 0.50 | 0.00 | 1.00 |
| hisp_mat | 1342 | 0.25 | 0.43 | 0.00 | 1.00 |
| white_ma | 1342 | 0.46 | 0.50 | 0.00 | 1.00 |
| no_match | 1342 | 0.30 | 0.46 | 0.00 | 1.00 |
| group | 1342 | 0.50 | 0.50 | 0.00 | 1.00 |
| sa_dif | 1342 | 4.09 | 4.39 | -10.00 | 20.00 |
| sa_difm1 | 1342 | 0.93 | 2.18 | -7.00 | 9.00 |
| sa_difm2 | 1342 | 3.17 | 3.55 | -8.00 | 16.00 |
| std_gend | 1342 | 0.49 | 0.50 | 0.00 | 1.00 |
| hisp_rac | 693 | 1.00 | 0.00 | 1.00 | 1.00 |
| stdracw | 1342 | 0.48 | 0.50 | 0.00 | 1.00 |

Table 2.9

*Teacher Level Descriptive Statistics*

| Variable | N | M | SD | Min. | Max. |
|---|---|---|---|---|---|
| tch_race | 87 | 0.25 | 0.44 | 0.00 | 1.00 |
| class_si | 87 | 19.89 | 5.96 | 2.00 | 32.00 |
| tch_gend | 87 | 0.79 | 0.41 | 0.00 | 1.00 |
| group | 87 | 0.49 | 0.50 | 0.00 | 1.00 |
| clrace | 87 | 0.43 | 0.50 | 0.00 | 1.00 |
| tch_age | 87 | 42.69 | 10.05 | 25.00 | 68.00 |
| tch_expe | 87 | 10.44 | 8.58 | 0.00 | 41.00 |
| tch_math | 87 | 12.06 | 9.61 | 0.00 | 37.00 |
| tchexpec | 87 | 54.79 | 13.24 | 21.00 | 86.00 |
| tchperfs | 87 | 2.92 | 0.53 | 1.67 | 4.00 |
| tchmasti | 87 | 3.40 | 0.64 | 2.25 | 5.00 |
| tchperfi | 87 | 2.60 | 0.72 | 1.00 | 4.60 |
| tchpeffi | 87 | 3.26 | 0.36 | 2.57 | 4.29 |
| tchmasts | 87 | 46.29 | 16.82 | 2.00 | 86.67 |
| tchracw | 87 | 0.75 | 0.44 | 0.00 | 1.00 |

Table 2.10

*School Level Descriptive Statistics*

| Variable | N | M | SD | Min. | Max. |
|---|---|---|---|---|---|
| poverty | 73 | 0.53 | 0.27 | 0.04 | 0.99 |
| school_s | 73 | 590.77 | 398.75 | 71.00 | 2460.00 |
| percenaf | 73 | 0.05 | 0.05 | 0.00 | 0.22 |
| percenas | 73 | 0.02 | 0.04 | 0.00 | 0.22 |
| percenhi | 73 | 0.46 | 0.34 | 0.04 | 1.00 |
| percenwh | 73 | 0.47 | 0.32 | 0.00 | 0.96 |
| percentg | 73 | 0.10 | 0.05 | 0.00 | 0.30 |
| percents | 73 | 0.13 | 0.04 | 0.06 | 0.26 |
| percente | 73 | 0.07 | 0.11 | 0.00 | 0.65 |

The multi-level level model simultaneously estimated the effect of student level, classroom-level, and school-level variables. Conceptually a separate regression model was fitted for each classroom. The regression models yielded a mean math gain score for each classroom adjusted for the experimental condition impact. Intercepts for the individual classrooms/teachers then become dependent in the model at level-2 to support my explanation for the variation in classrooms while controlling for differences between the experimental and the control group. Similarly, teacher level intercepts were modeled as dependent variables at the school level.

## Analytic Models

The results of the analysis for student math gains M2 (complex and conceptually difficult mathematics in Table 2.3) are presented in six models. Model 1 examines the effects of teacher-student (individual and classroom majority) racial matching focusing on the contrast between matched and unmatched conditions. Model 2 explores the teacher-student White-White, vs. Hispanic-Hispanic match. Model 3 focuses on teacher and student variability in race on math performance. Model 4 addresses the alignment of teacher perceptions/expectations of student performance for marginalized students' actual performance when there is a match of teacher and student by race and ethnicity. Model 5 is presentation of the results of the SimCalc treatment effect for match and unmatched students. Finally, model 6 reveals if the SimCalc treatment will moderate the effects of teacher perceptions/expectations of minority students' academic performance for Hispanic students who are an ethnic match or mismatch with their teacher.

The first step in the analysis began with the estimation of a base model that is equivalent to a one-way random effect analysis of variance (Hoffman, 1997; Lee & Bryk, 1989). This model has no L-1, L-2 or L-3 predictors. It provided useful preliminary information about the partitioning of the total variance of the dependent variable into between school, teacher, and student components (Hoffman, 1997; Raudenbush & Bryk, 2002). This unconditional model allows for calculation of the intraclass correlation coefficient (ICC), the clustering or nesting effect of the data for a precise measure of between cluster variance. However, in this study the differences between school and teacher variance could not be parsed out precisely as an aggregate though we have reasonably precise numbers because we are limited to mostly one teacher per school. The variance explained with the model specification parameters for M2 gain score was 61% student level, 21% teacher or classroom level and 18% school level. The unconditional model for $Y_{ijk}$ of M2, M1, and Total gain scores were as follows:

Mixed-Effect Model (single analytic framework)

$$Y_{ijk} = [\ \gamma_{000}\ ] + [\ r_{0} + u_{00} + e\ ]$$

*fixed* *random*

Thus, the ICC estimate suggests that the multi-level nesting model chosen should be used to accurately account for all the variation in the sample given the nesting of the data. A multi-level covariance three level HLM model is where I began to model build and continued until a final models were arrived at that answered my research questions. The basic experimental model for three different outcomes of student math scores (M1-gains, M2-gains, and Total-gains) is:

Level-1 Model (students)

$Y_{ij}$ (student math scores) = $\pi_{0jk} + e_{ijk}$

Level-2 Model (teachers/classrooms)

$\pi_{0jk} = \beta_{00} + \beta_{01} W_{jk}$ (group) + $r_{jk}$

$W_{jk}$ = {1, if teacher j of school k is in experimental group}

{0, if teacher j of school k is in control group}

Level-3 Model (schools)

$\beta_{00} = \gamma_{000} + u_{k}$

$\beta_{01} = \gamma_{010}$

Mixed-Effect Model (single analytic framework)

$$Y_{ijk} = [\ \gamma_{000} + \gamma_{010} + \gamma_{100}(W_{j})\ ] + [\ r_{0} + u_{00k} + \varepsilon_{ijk}\ ]$$

*fixed* *random*

$Y_{ijk}$ = math gain score for student $i$ of teacher $j$ in school $k$

$W_{jk}$ = 1 if teacher $j$ *of school* $k$ is in a treatment group, 0 if in a control group for student $i$

$u_k$ = random intercept term for school $k$

$r_{jk}$ = random intercept term for teacher $j$ in school $k$

$\varepsilon_{ijk}$ = random error for student $i$ of teacher $j$ in school $k$

I analyzed a corpus centered around student learning gains gathered in the context of a successful focused, randomized, controlled experiment of middle school mathematics learning that contrasted a 3-week curricular unit using SimCalc Mathworlds curriculum and a TEXTEAMS control. This secondary data analysis resulted in performance data from the 92 7th grade mathematics teachers in several regions of Texas and 1342 of their students.

The researchers' model design therefore supports the following hypotheses in the 3-level multilevel HLM analysis controlling for SES (poverty), class size, and school size shows:
*Hypothesis 1:* Students taught by teachers with similar racial and ethnic backgrounds will have higher gains (individual and classroom majority match) in math learning.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{100}(race\_mat) + r_0 + u_{00} + \varepsilon$$

Model 2.1

*Fixed Effects of M2Gains on Racial and Ethnic Matching*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | 1.48 | 0.89 | 1.67 | 70 | 0.099 |
| poverty | 0.03 | 0.66 | 0.05 | 70 | 0.960 |
| school_size | -0.00 | 0.00 | -2.24 | 70 | 0.028 |
| class_size | 0.00 | 0.03 | 0.18 | 84 | 0.860 |
| group | 3.48 | 0.30 | 11.44 | 84 | 0.000 |
| race_match | 0.47 | 0.19 | 2.51 | 1336 | 0.012 |

Model 2.2

*Fixed Effects of M2Gains on Classroom Majority Racial and Ethnic Matching*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | 1.58 | 1.13 | 1.40 | 70 | 0.166 |
| poverty | -0.16 | 0.93 | -0.17 | 70 | 0.864 |
| school_size | -0.00 | 0.00 | -1.36 | 70 | 0.179 |
| tch_race | 0.28 | 0.53 | 0.53 | 82 | 0.598 |
| class_size | 0.00 | 0.04 | 0.16 | 82 | 0.876 |
| group | 3.26 | 0.38 | 8.54 | 82 | 0.000 |
| clrace_match | 0.06 | 0.39 | 0.16 | 82 | 0.873 |

Of particular importance, the number of students who were racially or ethically matched with their teacher was significantly larger than those students who were not when comparing matched to unmatched students. With "match" students the researcher combined White and Hispanic matched teacher and students. The expected mean value for matched students is .47 higher than the unmatched student. Hispanic and White students who were of the same racial or ethic group as their teacher had higher math gains than the mismatched students. There was no detectable effect of ethnic congruence on student math gains for the Hispanic students who were in classrooms where the teacher was Hispanic and the majority of the students in the class were also Hispanic (Model 2.2; b = 0.063; t(82) = 0.16, p < n.s.). The Hispanic students' scores were filtered out as the White students' scores were removed so that we may investigate the average Hispanic students classroom performance.

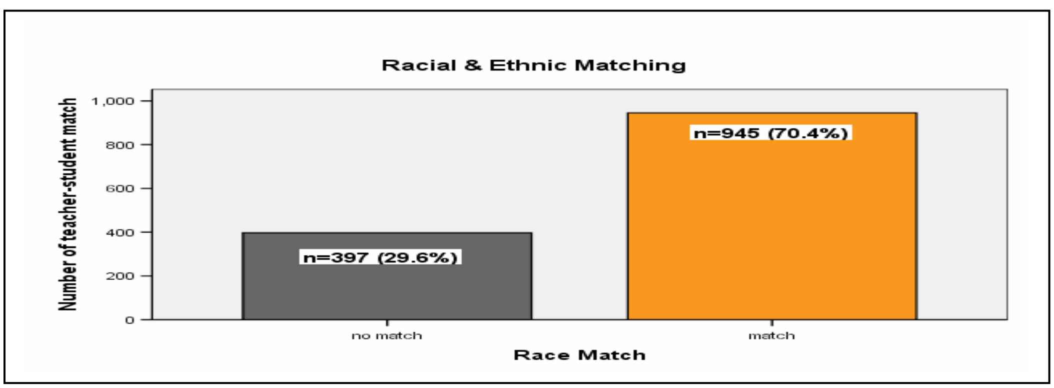


*Figure 2.5.* Racial and ethnic matching proportions.

The graph in Figure 2.5 shows the disproportionate number of matched (70.4%) students to unmatched (29.6%) students and Model 2.1 is evidence that a there is a significant effect of racial congruence on student-level math performance b = 0.473;  t(1336) = 2.51, p < 0.012).

The question becomes more complicated when we consider whether matching of a specific racial category is what may matter. That is, it may matter if you are a White student with a White teacher, but not if you are a Hispanic student with a Hispanic teacher. For the purposes of this exposition we created indicator variables for race/ethnicity as Hispanic student-Hispanic teacher match (hisp_match) and White student-White teacher match (White_match).

*Hypothesis* 2: Minority (Hispanic) students when compared to White students who are of similar ethnic and racial background as their teacher will have higher math gains.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{100}(race\_mat) + \gamma_{200}(Hispanic\_match) + r_0 + u_{00} + \varepsilon$$

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{100}(race\_mat) + \gamma_{200}(White\_match) + r_0 + u_{00} + \varepsilon$$

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{100}(Hispanic\_match) + \gamma_{200}(White\_match) + r_0 + u_{00} + \varepsilon$$

Model 2.3

*Fixed Effects of M2Gains on Racial Matching for White-White vs. Hispanic-Hispanic Match*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | 1.24 | 0.97 | 1.28 | 70 | 0.207 |
| poverty | 0.36 | 0.87 | 0.42 | 70 | 0.679 |
| school size | -0.00 | 0.00 | -2.04 | 70 | 0.045 |
| class size | 0.01 | 0.03 | 0.28 | 84 | 0.781 |
| group | 3.46 | 0.30 | 11.34 | 84 | 0.000 |
| hisp_match | 0.22 | 0.49 | 0.46 | 1335 | 0.649 |
| white_match | 0.54 | 0.21 | 2.62 | 1335 | 0.009 |

The difference in strength between White-White and Hispanic-Hispanic match in the Model 2.3 and Figure 2.6 shows the benefits of White-White match (b = 0.539;  t(1335) = 2.621, p < 0.009) are more pronounced than those of Hispanic-Hispanic match. The White students with a White teacher have an expected mean value of .54 higher than the mismatched teacher and students.

The initial findings raised the question of what was driving the White teacher White student match effect, therefore a subsequent analysis of the statistical effects of racial and ethnic student-teacher matching on student performance explained by the simple main effects of student and teacher race was investigated. There is a body of literature suggestive that being White is associated with privilege. The literature also shows that White students traditionally outperform Hispanic students 4 to 1 particularly in math. However, there is not much evidence or strong claims modeling an additive benefit for White students often paired with a White teacher over the Hispanic student with a Hispanic teacher. There are additional studies that focus on the impact of student and teacher race on student learning in the classroom.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{030}(tch\_race) + \gamma_{100}(std\_race) + r_0 + u_{00} + \varepsilon$$

Model 2.4

*Final Estimation of Fixed Effects of M2Gains for Student and Teacher Race*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | 3.26 | 1.51 | 2.16 | 70 | 0.034 |
| poverty | 0.70 | 1.15 | 0.61 | 70 | 0.543 |
| school_size | -0.00 | 0.00 | -1.03 | 70 | 0.306 |
| class_size | -0.02 | 0.05 | -0.38 | 84 | 0.705 |
| tchracw | 0.06 | 0.65 | 0.09 | 84 | 0.926 |
| stdracw | 0.48 | 0.21 | 2.21 | 1336 | 0.027 |

There was no detectable effect of teacher race/ethnicity as evident in Figure 2.6 and Model 2.4 (b = 0.061; t(84) = 0.094; p = n.s.) above and beyond student race/ethnicity (b = 0.475; t (1336) = 2.213; p < .05). While I expected that the White teacher-student match would demonstrate a double advantage for White students; being a White student and having a White teacher, there is no significant main effect for being a White teacher. However, the expected mean for White students is .48 higher with a White teacher than with a Hispanic teacher and there is a significant effect main effect for being a White student.

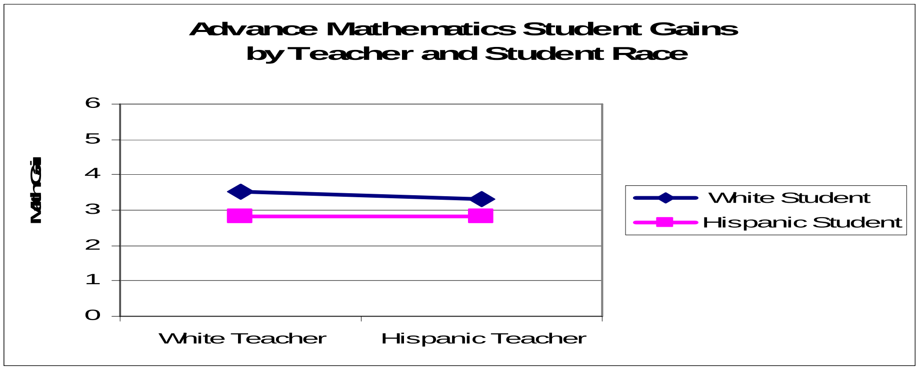


*Figure 2.6.* Advance mathematic student gains by teacher and student race.

Much of the research investigating student-teacher congruence was centered on teacher expectations with the strong claim that teacher expectations were a mediating factor effecting student performance. That is, teacher expectations of minority student performance effects minority students' performance and racial matching effects the teacher expectations. I was able to test this exposition in my study in a new and slightly different manner with hypothesis 3 and 5.

*Hypothesis 3:* Teacher perceptions/expectations of student performance will be more in alignment with their performance for marginalized students when there is a match of teacher and student by race and ethnicity.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{030}(tch\exp ec)$$
$$+ \gamma_{100}(race\_mat) + \gamma_{110}(tch\exp ec * race\_mat) + r_0 + u_{00} + \varepsilon$$

Model 2.5

*Fixed Effects of M2Gains on Racial Matching for Overall Teacher Expectations for Hispanic Students Only and Teacher Expectations and Racial Matching Interactions*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | -0.83 | 1.63 | -0.513 | 70 | 0.609 |
| poverty | 0.76 | 0.93 | 0.812 | 70 | 0.420 |
| school_size | -0.00 | 0.00 | -1.220 | 70 | 0.227 |
| class_size | 0.02 | 0.04 | 0.531 | 83 | 0.596 |
| group | 3.23 | 0.36 | 8.958 | 83 | 0.000 |
| tchexpec | 0.03 | 0.01 | 2.428 | 83 | 0.018 |
| race_match | -0.10 | 0.53 | -0.179 | 685 | 0.858 |
| tchexpec* race_match | -0.07 | 0.03 | -2.049 | 685 | 0.041 |

Theoretical background suggests that minority students' performance is especially vulnerable to teacher expectations of their performance and unfortunately White teachers have lower expectations of minority student performance than do minority teachers. Therefore, matching minority students with a minority teacher of the same racial and ethnic background might improve minority student performance as the minority teacher should have higher expectations of the students' performance. The results reported here do not support these claims.

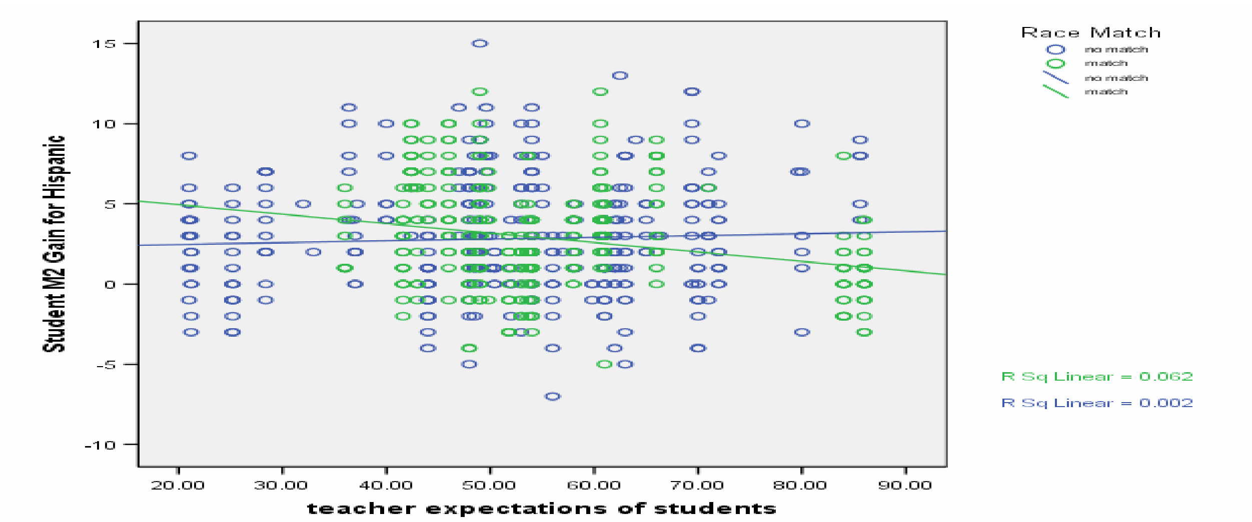


*Figure 2.7*. Scatterplot of M2math gains for Hispanic match and unmatched students vs. teacher expectations.

The accuracy of Hispanic and White teachers expectations of Hispanic students math performance differ significantly as shown in Model 2.5 and Figure 2.7. The relationship between Hispanic teachers expectations and Hispanic students performance (b = -0.067; t(685) = -2.049; p <0.041) is significantly different from that of White teachers, and in fact is negative (and then list the sum of the two coefficients to represent the actual value)

It has been shown that there is a main effect for SimCalc treatment and control group, but is there an interaction effect?

*Hypothesis 4:* The effect of the SimCalc treatment will vary depending on whether the student matches the teacher in race and ethnicity.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(group) + \gamma_{100}(race\_match)$$
$$+ \gamma_{110}(group * race\_match) + r_0 + u_{00} + \varepsilon$$

Model 2.6

*Final Estimation of Fixed Effects of M2Gains for SimCalc Treatment and Racial Matching Interaction*

| *Fixed Effects* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | 1.57 | 0.89 | 1.756 | 70 | 0.083 |
| poverty | 0.06 | 0.67 | 0.090 | 70 | 0.929 |
| school_size | -0.00 | 0.00 | -2.208 | 70 | 0.030 |
| class_size | 0.00 | 0.03 | 0.160 | 84 | 0.873 |
| group | 3.30 | 0.39 | 8.418 | 84 | 0.000 |
| race_match | 0.34 | 0.24 | 1.389 | 1335 | 0.165 |
| group *race_match | 0.25 | 0.37 | 0.679 | 1335 | 0.497 |

The expected mean for SimCalc treatment Hispanic and White matched students is 5.47 while statistically controlling for poverty, school size, and class size (as shown in Model 2.6). There is no evidence to support the hypothesis that effect of the SimCalc treatment (b = 0.25; t (1335) = .68; p = n.s.) will vary depending on whether the student matches the teacher in race and ethnicity. The expected mean for SimCalc matched students is 3.55 higher than control matched students. Figure 2.8 illustrates SimCalc robust mathematic gains, in other words the SimCalc treatment effect is beneficial for all students in match and unmatched conditions.

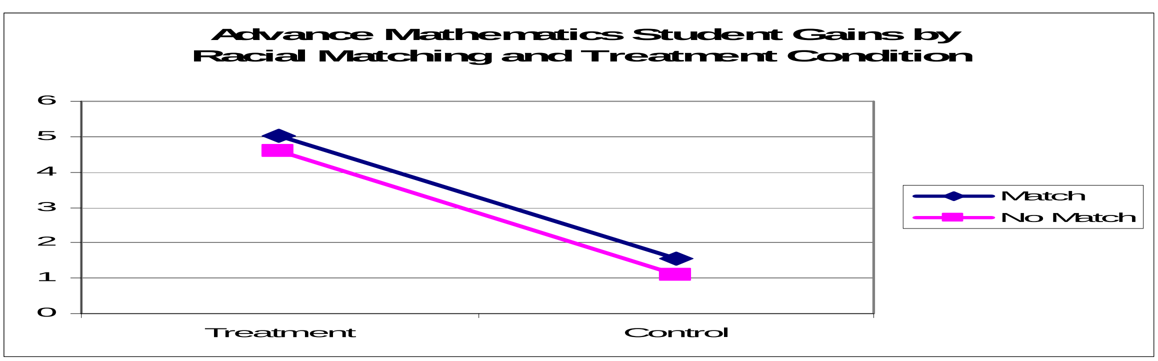


*Figure 2.8.* Advance mathematics student gains by racial matching and SimCalc treatment condition.

*Hypothesis 5:* SimCalc treatment will moderate the effects of teacher perceptions/expectations on minority students' academic performance for Hispanic students who are an ethnic match or mismatch their teacher.

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(poverty) + \gamma_{002}(school\_size) + \gamma_{010}(class\_size) + \gamma_{020}(tch\exp ec) + \gamma_{100}(group) + \gamma_{110}(tch\exp ec * group) + r_0 + u_{00} + \varepsilon$$

Model 2.7

*Final estimation of Fixed Effects of M2Gains for SimCalc Treatment and Group Interaction*

| *Fixed Effect* | *β* | *SE* | *t* | *df* | *p* |
|---|---|---|---|---|---|
| grand intercept | .36 | 1.10 | 1.23 | 70 | 0.225 |
| Poverty | 0.27 | 0.83 | 0.33 | 70 | 0.746 |
| school_size | -0.00 | 0.00 | -1.31 | 70 | 0.194 |
| class_size | 0.01 | 0.03 | 0.26 | 84 | 0.793 |
| Tchexpec | 0.06 | 0.02 | 0.74 | 84 | 0.461 |
| Group | 3.24 | 0.39 | 8.36 | 686 | 0.000 |
| tchexpec*group | -0.01 | 0.03 | -0.40 | 686 | 0.692 |

The interaction effect between of teacher expectations and the SimCalc treatment as shown in Model 2.7 (b = -0.010; t(686) = -0.396, p = n.s.). There is no difference in the effect of teacher expectations of minority student performance between the SimCalc treatment and control group. In addition, there is no evidence that the SimCalc treatment moderated the effects of teacher perceptions/expectations on minority students' academic performance in ethnically student-teacher match or mismatch classroom conditions for the Hispanic students only as hypothesized.

## Discussion of Findings

The relationship between race and performance is a crucial issue in American schools. In recent years, considerable attention has been given to the great deal of discussion in the literature about the impact of both unintentional and consequential matching of teacher and student by race and ethnicity. Some argue strongly against considering race when placing students in classrooms and schools and in evaluating student academic performance. These argue therefore that matching should not be considered. Other educators and researchers are willing to consider matching, but disagree about whether it is effective or not (Muller, 1998; Oats, 2003). The

Supreme Court of the United States has ruled on cases more recently regarding the constitutionality of assigning students to schools and classrooms based on racial identity. Despite the fact that many studies have shown that race plays a major role in student-teacher interaction (Alexander, Entwisle, & Thompson, 1987; Ainsworth-Darnell, & Downey, 1998; Brewer, Ehrenberg & Goldhaber, 1994; Downey & Pribesh, 2004; Farkas et al., 1990; Ferguson, 2003; Irvine, 1986; Oates, 2003), others have not and the Court has ruled it unconstitutional. I extend past work by comparing the effects of student-teacher matching in the context of a randomized control experiment, adding consideration of Hispanic students and teachers, controlling for covariates such as poverty, school and class size, the use of an advanced and more appropriate statistical tool for analysis (HLM), and a wide variety of teacher, student, and school characteristics and properties.

The performance data from 92 7$^{th}$ grade mathematics teachers and 1342 of their students examining the effects of racial and ethnic matching on student math learning gains in controlled experiment resulted in eight inter-related outcomes (1) a statistically significant effect for student-teacher racial and ethnic congruence in which matched students perform better than unmatched students (2) an effect for White student-teacher match in which matched White students perform better than unmatched White students (3) no effect of teacher-student racial and ethnic congruence for the Hispanic student- teacher match by itself, (4) an effect for being a White student that drives the race match effect, in which White students perform better than Hispanic students, (5) no effect of teacher race on student performance, (6) a negative correlation between Hispanic teacher expectation and Hispanic student mathematics gain at the classroom level, (7) a strong, positive effect for the SimCalc treatment for all students, but no interaction with whether the students were matched or unmatched, or with race/ethnicity, (8) no evidence that the SimCalc treatment moderates the effects of teacher perceptions/expectations on minority students' academic performance for Hispanic students who are an ethnic match or mismatch their teacher.

Table 2.11

*Summary of Racial and Ethnic Congruence Results*

| *Research Hypothesis (H1)* | *Main Effect* | *Coefficient* | *P* |
|---|---|---|---|
| **H1:** Race/Ethnic Match (individual students) | supported | 0.473 | 0.012 |
| **H1a:** Race/Ethnic Match (classroom majority match) | not supported | 0.063 | 0.873 |
| **H2:** White-White vs. Hispanic-Hispanic Match | supported | 0.539 | 0.009 |
| **H2a:** Teacher Race/ Match Interaction | supported | 0.475 | 0.027 |
| **H2b:** Student Race/ Match Interaction | not supported | 0.061 | 0.926 |
| **H3:** Race Match/ Teacher Expectations Interaction | supported | -0.067 | 0.041 |
| **H4:** SimCalc/Race Match Interaction | not supported | 0.254 | 0.497 |
| **H5:** SimCalc/Teacher Expectation Interaction | not supported | -0.010 | 0.692 |

This work has examined the question of racial and ethnic matching in the context of the Simcalc data set. Initial results testing the hypothesis, derived from the literature, that racial/ethnic matching would show a positive effect on performance; suggest that racial and ethnic congruence does account for variance in student math performance. The results in this analysis were in the right direction to support the hypothesis that while statistically controlling for poverty, class size, and school size student math gains would be higher for students with similar racial and ethnic backgrounds as their teacher. The empirical evidence in the literature on the effects of student-teacher racial congruence is mixed. For example, among supportive empirical effects of racial matching include Dee (2001) who concluded that White and Black students learned more in math and science when they were matched with a teacher of the similar racial backgrounds when compared to the mismatch condition.

However, the story is not so simple. I found that White students' math scores increased when they had a White teacher compared to Hispanic students' scores when they were matched with a Hispanic teacher. That is, contrary to the literature which claims benefits to the minority student through matching, the overall effect of matching was primarily driven through its effects on White students matched with White teachers. Furthermore, teacher-student classroom majority match, that is, when the teacher matches 50% or more of the classroom ethnicity, was not a significant predictor of the student classroom level performance for either Hispanic or White students.

My findings were supportive of the overall effect of racial matching on student performance but that effect dissolved as I further investigated the comparison between White-White and the Hispanic-Hispanic teacher student match. In fact, there was no evidence to support racial and ethnic student-teacher matching for the Hispanic teacher Hispanic student match. This finding is in alignment with previous research that claims there is no effect of matching on student outcomes (Alexander, Entwisle, & Thompson, 1987; Ainsworth-Darnell, & Downey, 1998; Brewer, Ehrenberg & Goldhaber, 1994; Downey & Pribesh, 2004; Farkas et al., 1990; Ferguson, 2003; Irvine, 1986).

From previous research, I concluded that in addition to student-teacher interaction (Brewer, Ehrenberg & Goldhaber, 1994; Alexander, Entwisle, & Thompson, 1987; Farkas et al, 1990; Irvine, 1986; Ainsworth-Darnell, & Downey, 1998; Ferguson, 2003; Oates, 2003; Downey & Pribesh, 2004) four key findings have been consistently reported in the racial and ethnic matching literature linking teacher perceptions/expectations to minority student academic performance: (1) White teachers' have low expectations of Black students (Jamar & Pitts, 2005), (2) White teachers give Black students lower evaluations than Black teachers tend to give them (Downey & Pribesh, 2004; Ferguson, 2003; Alexander, Entwisle, & Thompson, 1987; Brewer, Ehrenberg & Goldhaber, 1994), (3) White teachers view White students as being more academically engaged than Black students (Downey & Pribesh, 2004; Ferguson, 2003), and (4) Black students are more receptive to teachers expectations and perceptions of their academic performance (Oates, 2003). None of the four major findings in the literature were supported in this study. In the current study teacher perceptions/expectations of student performance was found not to be in alignment with the students performance for marginalized students when there was a match of teacher and student by race and ethnicity. The higher the Hispanic teachers' expectations of the Hispanic students performance was the lower the students performed. One possible explanation for this finding is actually implied in the literature that perhaps Hispanic teachers may have higher expectations for Hispanic students and therefore hold them and expect higher performance from them, and the pressure applied results in lower student performance.

Middle school mathematics achievement gap continues to widen and minority students continue to lack opportunities to learn more rigorous and complex mathematics at such a pivotal point in their educational path (Kaput & Roschelle, 1996; Schmidt et al., 2001; Suter, 2002; Tatar et al., 2007). SimCalc intervention was overall successful in offering a wide variety of students an opportunity to learn more difficult and conceptually complex mathematics. There were no differences in the student math performance between SimCalc treatment and control group in the racially congruent and non-congruent teacher and students. This confirms that SimCalc's robust mathematics gains for all students in match and unmatched condition found in the overall effect of the Simcalc study. There were no compensatory effects for the SimCalc math intervention for the minority students under the racial and ethnic congruence conditions as we expected there to be. Simcalc had a democratizing effect that is equally strong for match and unmatched students**.** SimCalc treatment was not found to moderate the effects of teacher perceptions/expectations of minority students' academic performance for Hispanic students who are an ethnic match or mismatch their teacher.

## Limitations of Findings

Several factors suggest that the findings of the current study require careful interpretation. First, it is important to remember that there were only 22 Hispanic teachers in the study as compared to 70 White teachers. Thus, the possibility of a Hispanic match was constrained compared to that of a White match.

Although we did not predict an effect for White matching, perhaps these results are not as surprising as they seem. Historically, most students have been White, as have most teachers. In effect, the White student-teacher match has been the outperforming group in this country. The question is whether this state of affairs causes us to miss a more subtle racial/ethnic matching effect.

The standard error in the Hispanic match condition was much higher than that in the White match condition. This suggests that more power in the Hispanic condition may have been required to detect real, underlying effects of matching. It also suggests that, despite the small numbers, the Hispanic match group may have hidden considerable internal complexity. The term "Hispanic" is used here to describe a range of ethnic conditions, combining White-Hispanic, Black-Hispanic, recent Mexican immigrants, middle-class and impoverished, educated and uneducated. Although we control for the SES of the school, we do not control for SES at the student level. It may be that matching a highly educated middle class Hispanic teacher with an impoverished student obscures the underlying effect of the match.

Another limitation in the study is that our gain scores reflect only a three-week intervention. While we would have expected SimCalc and the high quality control that we used to flourish most under the most positive classroom conditions, three weeks may not be sufficient to show such gain. Additionally, mathematics may not be the most sensitive subject to racial/ethnic matching.

## Interpretation of Findings and Conclusions

Three explanations of the current results are possible: (1) that the test reported here are, as just discussed, insufficiently sensitive to detect real underlying conditions, (2) that the situation of Hispanic students and teachers is quite different from that of Black students and teachers, or (3) that the racial/ethnic matching hypothesis is itself insufficiently developed.

The current data suggests that matching is not as effective in prediction of increases in minority student academic performance among the Hispanic teacher-student match condition as in their Black counterparts. This suggests that educators and researchers should lend more careful consideration to extending arguments and findings about Black students' academic performance to Hispanic students. It can be problematic to generalize beliefs about racial minorities from one to the next. Furthermore, the term "Hispanic" can itself hide racial distinctions. This condition is another explanation for why Hispanic students when matched with a Hispanic teacher were not affected the same way as Black students were when matched with a Black teacher.

Some research has suggested that any negative impact of matching is more pronounced when a White teacher is matched with African-American classrooms than the other way around (Oates, 2003). Perhaps the prior research suggestive that Black students are more susceptible to White teachers negative perceptions/expectations of their performance (Oats, 2003) is not an accurate predication or specific to the Black students under certain circumstances.

Although the evidence in the literature suggests that the low minority student math performance is linked to the mathematic teacher classroom practices, behaviors, and attitude (Mertens & Flowers, 2003; Glass, 2000) and to the racial and ethnic differences between teacher and students (Downey & Pribesh, 2004; Oates, 2003), not much empirical evidence has been given to support teachers race has an effect on student performance. In fact, Downey & Pribesh

(2004) concluded that the race of the teacher whether Black or White did not affect minority student academic performance. This study confirms the claims that there is no effect of teacher race on student performance. In these data, there was no appearance of the effect of teacher race and ethnicity as an under or over predictor of student performance above and beyond student race and ethnicity. In effect, there were no math learning gains for the White Hispanic students when they had a White teacher as compared to when they had a Hispanic teacher. However, there was a significant effect of student race on math learning gains for the White students. Thus, these data confirms an effect of race on performance. That is, the strong relationship between performance and race is fully explained by student race and ethnicity alone. This particular finding supports the findings that much of the variance in student academic performance can be explained at the student level. There are strong claims that the teacher makes the difference in the classroom but these results suggest that the teacher may matter but the student matters more in his or her own academic performance.

The implications of the findings from this racial and ethnic matching study includes clearly extending national studies by adding consideration of Hispanic students and teachers congruence conditions. Many of the prior studies national and local on racial matching, Black students and teachers were the minority group of interests. So while much has been studied looking at this particular minority group in comparison to White students and teachers more targeted research is needed as the results in the literature are mixed. Another lacking component in the literature which my study addresses is consideration of another minority projected to be the new minority majority that is the Hispanic ethnic group. However these results suggest that more in depth analysis with targeted Hispanic population should be investigated.

Another implication of this study involves recruitment of minority teachers. Many federally mandated programs and initiatives including No Child Legislation in 2002 have sparked more recruitment and retention of minority teachers in an effort to close the nationwide Black-White and the Hispanic-White achievement gap. There was no evidence to support the push for recruitment of more minority teachers in this study. Policymakers, educators, and students, particularly minority students believe that the lack of minority teachers and the prejudices and biases even if unintentional of the White teachers are even believed to be a contributing factor to the growing student achievement gap. While, the teaching force is increasingly White, and the public school student population is increasingly minority (National

Center for Educational Statistics, 2003a; White-Clark, 2005; Oates, 2003; Ladson-Billings, 2004), there is a lack of evidence showing that the teachers race is a possible problem needed to address the issues. In fact the more research attempts to link the teachers race to explain student outcomes, new, different, and more difficult questions arise that show just how challenging and complex it is to address issues of race in the classroom. Unfortunately, this research unveils the complexity of the issue as well and in turn confirms that more targeted research needs to be done. Studies such as this one have failed to show strong support for the effect of racial and ethnic matching. The student achievement gap by race and ethnicity certainly suggest that race plays a role but perhaps as revealed in this study it may not be the race or ethnicity of the teacher that matters just the race or ethnicity of the students.

I remain hopeful that racial and ethnic teacher-student matching for minority teachers and students can lead to better understanding in the classroom, enhance teacher-students interaction, and in turn lead to improved student academic performance which will close the Hispanic-White achievement gap, though we offer no new evidence of such effects. But instead our results suggest that further, more careful, and targeted investigation of racial and ethnic matching between student and teacher in the classroom is needed with direct relationship to student achievement outcome measures as was examined in this study. The findings do not provide support that matching conditions predict student math gains for the minority students and therefore does not contribute to the closing of the White-Hispanic math achievement gap. In the end, the White student advantage discussed in hypothesis 1 was masquerading as a “match effect.” Researchers need a more sophisticated analysis of matching to include the developmental stages of students and content based specific. The findings here are inconclusive and more randomized controlled experimental studies are needed to address this topic. In addition, these results support the need for a mixed method approach, and perhaps a controlled experiment (to the extent possible).

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APPENDIX A

TEACHER BACKGROUND QUESTIONNAIRE

**Name:_____________________________________**

**Date:_____________________**

**Teacher Background Questionnaire**

**Academic Background**

**Please list the undergraduate and graduate institutions attended, as well as year, major or program, and degrees/certificates obtained**

| Institution | Year | Major/Program | Degree | Professional Certificates |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| |
|---|
| What was your score on the Texas state licensing examination?_________________________________ |
| How many courses in mathematics (not math education) have you taken altogether in college and afterwards?______________ |
| How many courses in math education have you taken altogether in college and afterwards?___________ |
| How many courses in pedagogy have you taken altogether in college and afterwards?_______________ |

| |
|---|
| Is teaching your first career? Yes No |
| If not, what was your career prior to teaching?______________________________________________ |

**Languages**

**Please list all the languages that <u>you</u> speak, as well as your general fluency with these languages:**

| Language | How well do you speak this language? | | |
|---|---|---|---|
| | A little | Fairly well | Fluently |
| | | | |
| | | | |
| | | | |
| | | | |

**Please list the languages that <u>your students</u> speak as a first language, as well as the percentage of your students speaking this language.**

| Language | Percent of students speaking this language |
|---|---|
| | |
| | |
| | |
| | |

What was the primary language spoken in the home you grew up in?

______________________________________________

**Professional Practices**

**For each grade level, please write the number of years you have taught that grade.**

| Grade | Years Teaching Mathematics | Years Teaching Total |
|---|---|---|
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

| |
|---|
| How many hours of math homework do you expect your students to do a week? ____________________<br>Since starting at your current school, have you participated in any peer teams at your school or elsewhere, for example, interdisciplinary, grade level, administrative, school improvement, content area, student support, special focus, or other? Yes □ No □<br>Do other teachers in your school participate in such teams? . Yes □ No □<br>How many years has your school's principal held his/her current position? __________________ |
| What school changes has your principal initiated in the last two years?<br>____________________________________________________________<br>____________________________________________________________<br>____________________________________________________________<br>____________________________________________________________<br>How many grant writers are employed by your school?________________________________<br>What is the absentee rate in you classes?____________________________________________<br>What is the absentee rate in your school?____________________________________________ |

**On average, how often do you discuss the following topics in conversations with parents? (Check one box per row)**

| | At least once a week | Once or twice a month | Once every few months | Once a year | Never |
|---|---|---|---|---|---|
| Student performance and problems | | | | | |
| Homework to do with students | | | | | |
| Information and activities to increase parent involvement | | | | | |
| Information or referrals for health & social services | | | | | |
| Other ___________________________ | | | | | |
| Other ___________________________ | | | | | |

| |
|---|
| On a scale of 1-5, in which 1 means very safe and 5 means very unsafe, how safe, physically, do you feel in your school?<br><br>(1 = very safe)__________________________________(5 = very unsafe) |

On a scale of 1-5, in which 1 means very secure and 5 means very insecure, how secure do you feel in your job?

(1 = very secure)_____________________________(5 = very insecure)

**Please check each of the following courses that you have taken and passed in college or since.**

**Mark all courses that have a substantial overlap with the course that you have taken.**

**ALGEBRA-Not counted towards graduation credit**
a brief review of elementary algebra; linear, quadratic, exponential, and logarithmic functions; polynomials; systems of linear equations; applications.

**INTRODUCTION TO MATHEMATICS-for liberal arts majors**
number theory (divisibility, prime numbers, the Fundamental Theorem of Arithmetic, gcd, Euclidean Algorithm, modular arithmetic, special divisibility tests), probability (definition, laws, permutations and combinations), network theory (Euler circuits, traveling salesman problem, bin packing), game theory

**APPLICABLE MATH -for liberal arts majors**
linear and quadratic equations, systems of linear equations, matrices, probability, statistics, exponential and logarithmic functions, and mathematics of finance.

**ELEMENTARY FUNCTIONS AND COORDINATE GEOMETRY-for liberal arts majors**
covers sets, algebra of functions, inverse functions, logarithms, exponential functions, trigonometric functions, inverse trigonometric functions, polynomials, and the range, domain and graphs of these functions.

**ELEMENTARY STATISTICAL METHODS-not for math majors**
descriptive statistics - measures of central tendency, measures of dispersion. Probability - basic rules of probability, joint and marginal probabilities. Statistical modeling - normal and binomial distributions, sampling distributions. Inferential statistics - estimating means and proportions, hypothesis tests, regression and correlation.

**FOUNDATIONS OF GEOMETRY, STATISTICS, AND PROBABILITY-not for math majors**
An analysis, from an advanced perspective, of the basic concepts and methods of geometry, statistics, and probability, including representation and analysis of data; discrete probability, random events, and conditional probability; measurement; and geometry as approached through similarity and congruence, through coordinates, and through transformations.

**FUNCTIONS AND MODELING-for education students**
lab-based activities designed to strengthen and expand knowledge of the topics in secondary mathematics, focusing especially on topics from precalculus and the transition to calculus. Students will explore a variety of contexts that can be modeled using families of functions, including linear, exponential, polynomial and trigonometric functions. Topics involving conic sections, parametric equations and polar equations will be included. Explorations will involve the use of multiple representations,

transformations, data analysis techniques(such as curve fitting) and interconnections among geometry, probability and algebra.

**FOUNDATIONS OF ARITHMETIC-for elementary math teachers**

An analysis, from an advanced perspective, of the concepts and algorithms of arithmetic, including sets; numbers; numeration systems; definitions, properties, and algorithms of arithmetic operations; and percents, ratios, and proportions.

**FOUNDATIONS OF NUMBER SYSTEMS-for education students**

place value and arithmetic operations, prime factorization and other properties of integers; irrational and transcendental numbers; complex numbers; properties of polynomials; and connections of these topics with other areas of mathematics.

**MATHEMATICS PROBLEM SOLVING-for secondary math teachers**

include discussion of heuristics, strategies, and methods of evaluating problem solving. Communicating mathematics, reasoning, and connections between various mathematical topics will be emphasized.

**STRUCTURE OF MODERN GEOMETRY-for secondary math teachers and math majors**

includes study of axiom systems, transformational geometry, and an introduction to non-Euclidean geometries

**INTEGRAL CALCULUS**

transcendental functions, techniques of integration, and applications of the integral.

**MULTIVARIABLE CALCULUS**

infinite series, power series, vectors, vector calculus, functions of several variables, partial derivatives, gradients, and multiple integrals.

**DIFFERENTIAL CALCULUS**

limits, continuity, differentiation, and the mean value theorem and its applications.

**LINEAR ALGEBRA AND MATRIX THEORY**

Matrices, Linear equations, Vector spaces, Inner product spaces, Linear Transformations, Determinants, Eigenvalues

**INTRODUCTION TO SCIENTIFIC COMPUTING**

**DISCRETE MATHEMATICS**

Fundamentals of logic, Functions, Relations, Introductory graph theory:

**INTRODUCTION TO NUMBER THEORY**

Divisibility; Congruences

**MATRICES AND MATRIX CALCULATIONS**

matrix operations, systems of linear equations, introductory vector-space concepts (e.g., linear dependence and independence, basis, dimension), determinants, introductory concepts of eigensystems introductory linear programming, and least square problems.

**INTRODUCTION TO ALGEBRAIC STRUCTURES**

Elementary properties of the integers, groups, rings, and fields are studied.

**THEORY OF FUNCTIONS OF A COMPLEX VARIABLE for engineering students**

Cauchy’s integral theorem and formula, Laurent expansions, residue theory and the calculation of definite integrals, analytic continuation, and asymptotic expansions. Rigorous proofs are given for most results, with the intent to provide the student with a reliable grasp of the results and techniques.

**INTRODUCTION TO REAL ANALYSIS**

the real number system, of real sequences, and of limits, continuity, derivatives, and integrals of real-valued functions of one real variable.

**PROBABILITY I**

Principles of set theory and a set of axioms for probability are used to derive some probability density and/or distribution functions. Special counting techniques are developed to handle some problems. Properties associated with a "random variable" are developed for the usual elementary distributions. Both theorem proving and problem solving are required.

**INTRODUCTION TO STOCHASTIC PROCESSES**

Introduction to Markov chains, birth and death processes, and other topics.

**VECTOR AND TENSOR ANALYSIS I**

vector algebra and calculus, integral theorems, general coordinates, invariance, tensor analysis, and perhaps an introduction to differential geometry. It is anticipated that a significant percentage of students will be physics majors.

**VECTOR AND TENSOR ANALYSIS II**

emphasis on tensor and tensor analysis, Riemannian geometry, and invariance.

**REAL ANALYSIS I**

Beginning with the notion of limit from calculus and continuing with ideas about convergence and the concept of function that arose with the description of heat flow using Fourier series, analysis is primarily concerned with infinite processes, the study of spaces and their geometry where these processes act and the application of differential and integral to problems that arise in geometry, pde, physics and probability.

**REAL ANALYSIS II**

A rigorous treatment of selected topics in real analysis, such as Lebesgue integration, or multivariable integration and differential forms.

**TOPOLOGY I**

Cardinality, Definitions of topological space, Countability properties, Separation properties, Covering properties, Continuity and homeomorphisms, Connectedness

**NUMERICAL MATHEMATICS FOR APPLICATIONS**

Introduction to numerical methods for applied problems in science and engineering.

**MATHEMATICS OF RISK**

Probabilistic risk theory applied to insurance.

**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**

**ALGEBRAIC STRUCTURES I**

normal subgroups, quotient groups, homomorphisms, permutation groups, the Sylow theorems, and the structure theorem for finite Abelian groups. The topics in ring theory include ideals, quotient rings, the quotient field of an integral domain, Euclidean rings, and polynomial rings.

**ALGEBRAIC STRUCTURES II**

topics in algebra chosen from field theory and linear algebra

**FOURIER AND LAPLACE TRANSFORMS**

**LINEAR REGRESSION ANALYSIS**

Fitting linear models to data by the method of least squares, choosing best subsets of predictors, and related materials.

**METHODS OF APPLIED MATHEMATICS I**

diagonalization of matrices, eigenfunctions and minimization, asymptotics of eigenvalues, separation of variables, generalized solutions, approximation methods.

**INTRODUCTION TO MATHEMATICAL STATISTICS**

estimation of parameters, including maximum likelihood estimation; sufficient statistics, and confidence intervals; testing of hypotheses including likelihood ratio tests and the Neyman Pearson theory; the distributions and other properties of some statistics that occur in sampling from normal populations such as the gamma, beta, chi-squared, Student's t, and F distributions; and fitting straight lines.

**ACTUARIAL STATISTICAL ESTIMATES I**

statistical estimates for frequency- and severity-of-loss random variables; credibility theory; statistics of simulation.

**TIME SERIES AND SURVIVAL MODEL ESTIMATION**

time series; forecasting; statistical estimation in survival models.

**CLASSROOM INTERACTIONS**

This course moves from a focus on thinking and learning to a focus on teaching and learning. Prospective teachers are introduced to the way in which curriculum and technology are used in classroom settings to build interrelationships among teachers and students. They are taught how content and pedagogy combine to make effective teaching.

**PROJECT-BASED INSTRUCTION**

In this course, students aim to master new technologies for problem-based investigations in math and science classrooms. Students also discuss the use of assessment to improve student learning. Students teach project-based lessons to high school students.

*Thank you very much for answering these questions!*

*We really appreciate your time and want you to know that we would not ask if it wasn't important.*

## YOUR TEACHING PHILOSOPHY

**The following paragraphs describe observations of two teachers' classes, Ms. Hill's and Mr. Jones'. Answer each question below by checking the box under the column that best answers that question for you.**

| Ms. Hill | Mr. Jones |
|---|---|
| Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly; based on the reading they had done the day before. After this review, Ms. Hill taught the class new material, again using simple questions to keep students attentive and listening to what she said. | Mr. Jones' class was also having a discussion, but many of the questions came from the students themselves. Though Mr. Jones could clarify students' questions and suggest where the students could find relevant information, he couldn't really answer most of the questions himself. |

| | Definitely Ms. Hill's | Tend towards Ms. Hil | Can't decide | Tend towards Mr. Jones' | Definitely Mr. Jones' |
|---|---|---|---|---|---|
| a. Which type of class discussion are you more comfortable having in class? | | | | | |
| b. Which type of discussion do you think most students prefer to have? | | | | | |
| c. From which type of class discussion do you think students gain more knowledge? | | | | | |
| d. From which type of class discussion do you think students gain more useful skills? | | | | | |

**Please fill in the percentages that complete the following statements,**

I expect that…

1.____% of my students will become high school graduates.

2.____% of my students will master algebra by the end of $8^{th}$ grade.

3.____% of my students will master algebra by the end of high school.

4.____% of my students will master calculus by the end of high school.

5.____% of my students will obtain a 4 year degree.

**Please rate how happy you are with each of the following aspects of your job:**

6. its intrinsic rewards

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

7. its collegiality

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

8. the administration

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

9. my input into decision making

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

10. student behavior

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

11. parent involvement

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

12. instructional resources

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

13. students doing homework

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| As unhappy as possible | | | | | Not happy or unhappy | | | | | As happy as possible |

**For the following questions, please circle the number that best corresponds to your agreement or disagreement with the statement.**

1. I give special privileges to students who do the best work.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

2. If I try really hard, I can get through to even the most difficult student.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

3. In this school, the importance of trying hard is really stressed to students.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

4. I make a special effort to recognize students' individual progress, even if they are below grade level.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

5. In this school, students are told that making mistakes is OK as long as they are learning and improving.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

6. Factors beyond my control have a greater influence on my students' achievement than I do.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

7. In this school, it's easy to tell which students get the highest grades and which students get the lowest grades.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

8. I am good at helping all the students in my classes make significant improvement.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

9. I display the work of the highest achieving students as an example.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

10. In this school, students who get good grades are pointed out as an example to others.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

11. During class, I often provide several different activities so that students can choose among them.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

12. In this school, students hear a lot about the importance of getting high test scores.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

13. I consider how much students have improved when I give them report card grades.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

14. In this school, a lot of the work students to is boring and repetitious.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

15. In this school, grades and test scores are not talked about a lot.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

16. In this school, students are frequently told that learning should be fun.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

17. I help students understand how their performance compares to others.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

18. Some students are not going to make a lot of progress this year, no matter what I do.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

19. I encourage students to compete with each other

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

20. In this school, the emphasis is on really understanding schoolwork, not just memorizing it.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

21. I point out those students who do well as a model for the other students.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

22. In this school, a real effort is made to recognize students for effort and improvement.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

23. I am certain that I am making a difference in the lives of my students.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

24. There is little I can do to ensure that all my students make significant progress this year.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

25. In this school, student hear a lot about the importance of making the honor roll or being recognized at honor assemblies.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

26. I give a wide range of assignments, matched to students' needs and skill levels.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

27. In this school, a real effort is made to show students how the work they do in school is related to their lives outside of school

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

28. I can deal with almost any learning problem.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

29. In this school, students are encouraged to compete with each other academically.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | | Somewhat Agree | | Strongly Agree |

Thank you very much! If you have any thoughts or questions about this questionnaire or any questions on it, please note them below:

APPENDIX B

IRB EXPEDITED APPROVAL

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24061
540/231-4991 Fax 540/231-0959
e-mail moored@vt.edu
www.irb.vt.edu
FWA00000572( expires 1/20/2010)
IRB # is IRB00000667

DATE: November 19, 2007

MEMORANDUM

TO: Deborah Tatar
Antionette Stroter

Approval date: 11/19/2007
Continuing Review Due Date:11/4/2008
Expiration Date: 11/18/2008

FROM: David M. Moore

SUBJECT: **IRB Expedited Approval:** "The Effects of Racial, Ethnic, and Linguistic Teacher-Student Congruence on Student Math Learning" , IRB # 07-585

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective November 19, 2007.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study's closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher's responsibility to obtained re-approval from the IRB before the study's expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

**Important:**
If you are conducting **federally funded non-exempt research**, this approval letter must state that the IRB has compared the OSP grant application and IRB application and found the documents to be consistent. Otherwise, this approval letter is invalid for OSP to release funds. Visit our website at http://www.irb.vt.edu/pages/newstudy.htm#OSP for further information.

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