A FORMULA FOR LOW ACHIEVEMENT: USING MULTI-LEVEL MODELS TO UNDERSTAND THE IMPACT OF INDIVIDUAL LEVEL EFFECTS AND SCHOOL LEVEL EFFECTS ON MATHEMATICS ACHIEVEMENT

A Thesis

by

KATHRIN ANN PARKS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2003

Major Subject: Sociology

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Approved as to style and content by:

Dudley Poston (Chair of Committee)	Joseph Jewell (Member)
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ABSTRACT

A Formula For Low Achievement:

Using Multi-level Models to Understand the Impact of Individual Level Effects and School Level Effects on Mathematics Achievement. (August 2003)

Kathrin Ann Parks, B.A., Loras College

Chair of Advisory Committee: Dr. Dudley Poston

The following study utilizes data from the High School and Beyond Study in order to predict mathematics achievement using both student characteristics and school level characteristics. Utilizing Hierarchical Linear Modeling, this study extends the body of literature by exploring how race, socio-economic status, and gender, as well as the percentage of minority students in a school, whether or not the school is Catholic, the proportion of students in the academic track, and the mean socioeconomic status of the school all affect mathematics achievement. Through this methodology, it was possible to see the direct effects of both student level and school level variables on achievement, as well as the cross-level interaction of all of these variables. Findings suggest that there are discrepancies in how different types of students achieve, as well as how those students achieve in varying contexts. Many of the variables were statistically significant in their effect on mathematics achievement. Implications for this research are discussed and considerations for future research are presented.

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CHAPTER I

INTRODUCTION

Education is considered by many to be a method of leveling the playing field. Some believe education to be an equalizer, where anyone who works hard enough can succeed. Children are told early in life that in order to be successful in life, in order to have a good job, in order to be valued by society, they must achieve academically. This belief is coupled with the idea that in the educational system, everyone has an equal opportunity to do well.

Education can be compared to a 400-meter race around a track. Many Americans believe that all students get to start in the same place in this race, that each student has an equal chance of coming out victorious in the end. In actuality, white students line up ahead of African American and Latino students. The latter have to run twice as hard to catch up to their competitors. They have to run without shoes. They run in schools without a track. They run for a team that does not value their contribution in the same way as it does their competitors. There are disparities in how different students are able to run this race. There are differences in the places where they run it. Every student does not have the same opportunity to win the race, just as not every student has the opportunity to achieve academically.

This thesis follows the style and format of the *American Journal of Sociology*.

It is well documented that there are disparities in how different kinds of students achieve, and many times these disparities have to do with characteristics that cannot be changed, related either to the students' characteristics or the characteristics of the schools they attend. Socioeconomic status, race, and gender all contribute to the level of achievement a student can obtain, as well as school level variables including the degree of tracking, the amount of money that a school receives, the percentage of minorities in the school population, whether the school is private or public, as well as other factors.

There are several explanations for why disparities exist. On the student level, some feel that low achievement has to do with the lack of outcomes that education brings (Willis 1990; Mickelson 1989), or that it has to do with reproducing existing class structures (Bourdieu 1977; Bowels and Gintis 1976). Some feel that academic ability is determined by genetics (Herrnstein and Murray 1994), while others feel that family background and peer influence are most important in contributing to disparities (Roscigno 1998). There is also the belief that poor and minority students are discriminated against in the school system because of their individual backgrounds, so that regardless of their ability they will not achieve at the same level as majority students (Oakes 1988).

There is also discussion about whether the individual factors are more or less influential on achievement than are school level factors. "While it is tempting to lay blame for low achievement and participation in mathematics and science on the disadvantages that poor and many minority students bring with them from home, their school experiences contribute to these disappointing outcomes as well" (Oakes 1988, p.

106). As we will see in later chapters, school effects can make a difference in how students achieve. The composition of the school, the level of tracking that occurs, and other factors all have an impact on student achievement. There are no easy solutions regarding which of these explanations best explain achievement disparities, and certainly, the question will not be completely answered in this thesis. However, by looking at school level variables and individual level variables, it is my hope to be better able to explain why minorities, working-class students and women score lower on mathematics achievement than white, middle to upper class males.

It is important to consider where American students stand regarding mathematics achievement. The National Center for Education Statistics reports that on average white students achieve higher mathematics scores than minorities that men scored higher than women. Although minority students have made gains in their overall mathematics achievement since 1990, large gaps still exist when their scores are compared to those of white students. For example, Hispanic students in 12th grade scored an average of 273 points of 500 points in 1990. In the year 2002, those average scores climbed to 283. African American students experience similar increases, in that in 1990 their average score was 268 and increased to 274 in 2000 (National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1990, 1992, 1996, and 2000 Mathematics Assessments). However, compared to white students, it is very apparent that an achievement gap exists.

For example, 12th grade white students in 1990 had an average mathematics score of 301, and in 2000 that score increased to 308. This means that in 1990, whites in

12th grade scored 33 points higher than 12th grade African American students, and 25 points higher than 12th grade Hispanic students. In 2000, the gap increased slightly with whites scoring 34 points higher than African Americans and 26 points higher than Hispanic students. (Similarly, males scored higher than females in grade 12, but the difference was not found to be statistically significant (National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1990, 1992, 1996, and 2000 Mathematics Assessments.). What we see from these findings is that though progress has been made, disparities still exist between white students and minority students.

In a time where legislation like the "No Child Left Behind Act" is in place, it is even more essential to understand what the possible causes of variance in mathematics achievement could be. There is a tendency in American society to blame the public school system for short changing their students. There is another tendency to blame parents for not getting involved. Test scores have become very important in deciding how a state or a school is provided with funding. Funding often determines the amount of resources that will be available to students. There is talk of school vouchers, parental choice, and improving teaching methodologies (U.S. Department of Education, "No Child Left Behind: What to Know-Introduction and Overview"). This rhetoric, which is now educational policy, in many ways is disruptive to the existing system.

If low achieving students are moved to higher achieving schools, this could affect the overall achievement levels of schools that are doing well. Shifting students from school to school will not help them achieve. Schools that already lack resources will

have to try to meet the same standards in the same time periods as schools with much more (Kozol 1991). Teachers will be focused on teaching to standardized tests, rather than making sure students have a true understanding of the subject matter. This scenario seems harmful and detrimental to students and schools.

"No Child Left Behind" (NCLB) places the blame for low achievement squarely on the shoulders of public schools, holding them accountable for academic achievement. Specifically for mathematics achievement, it is stated that, "Over the last decade, researchers have scientifically proven the best ways to teach reading. We must do the same in math. That means using only research-based teaching methods and rejecting unproven fads" (U.S. Department of Education. "No Child Left Behind: What To Know-The Facts About…Math Achievement"). While how a subject is taught is very important, as we will see when tracking is discussed more fully in the next chapter, NCLB does not take into consideration how student level variables and school level variables can interact to predict mathematics achievement.

Rather than legislating teaching methods, it might be necessary to investigate patterns of achievement. Rather than moving low achieving students around, perhaps there is a need to look at alternatives in the schools they currently learn in. Rather than searching for a scientific formula that will ensure high test scores, we need to have a fuller understanding of what the issues are. How this policy will affect school districts and students is yet to be seen. However, it is crucial that we have some understanding of what causes the disparity in mathematics achievement and to consider that the disparities could be the result of both individual and school level variables.

Statement of the Problem

As we have seen already, there is variance in how different students achieve in regards to mathematics. Because there is a belief that education creates opportunities for students to achieve in a neutral environment, disparities in achievement are problematic. Though many different possible explanations have been provided in previous research, it is still not clear if student level characteristics or school level variables influence achievement independently, or if there is an interaction between school level effects and individual level achievement slopes. It is essential to have an understanding of what causes disparities in order to inform decisions regarding educational reform.

Why choose mathematics achievement as a dependent variable in this study? While there are statistically important factors for choosing mathematics achievement that we will see in Chapter Three, there is also a value placed on mathematics by society, which makes it an appropriate measure of achievement for this research.

Mathematics relates to several aspects of day-to-day life and is an important component of many different types of careers. Having an aptitude for mathematics is valued by society. An understanding of advanced mathematics is often a means to high paying, high status positions in a number of fields. "The lack of higher level math skills among girls could foreclose careers in science and engineering and other math-related fields…In math-related fields both males and females earn more than they do in other fields, and income is particularly low in nonmathematical, female-dominated occupations (Eccles [Parsons] 1982)" (Entwisle, Alexander, and Olson 1994, p. 822). Though the previous statement focuses on how low mathematics achievement can affect

women's career choices, it is safe to assume that low achievement for minorities would have a similar effect.

Additionally, poor mathematics achievement early on in a student's academic career can have an effect on future choices. We will see to a great degree in the chapters that follow that tracking has a significant influence on student achievement. Oakes (1988) states that "three seemingly-interrelated factors appear to be critical to high levels of accomplishment: 1) access to math and science instruction; 2) early achievement in math and science which, in turn, leads to further instructional opportunities; and 3) the development of attitudes such as confidence, interest and willingness to study mathematics and science" (Oakes 1988, p. 112). What this indicates is that mathematics is a very important measure of achievement and is considered critical knowledge for gaining further entry into educational opportunities.

The importance of achievement in this subject area is also deemed very important by policy makers and legislators who create laws that guide educational practices. The Department of Education's "No Child Left Behind" website states:

> Math is a critical skill in the information age. We must improve achievement to maintain our economic leadership. While technology advances with lightning speed, stagnant math performance in schools shortchanges our students' future and endangers our prosperity and our nation's security. (U.S. Department of Education. "No Child Left Behind: What To Know-The Facts About…Math Achievement)

With the government placing this kind of significance on mathematics, it is even more critical that we have a full understanding of why gaps in achievement exist.

Hierarchical linear modeling (HLM) will help provide some insight into what causes disparities in mathematics achievement. By using this methodology, I will be

able to examine achievement at two levels. HLM allows us to see how student characteristics directly effect their mathematics achievement. It also allows us to see how school characteristics effect a school's mean mathematics achievement. Finally, we will be able to see if there are interactions between the student level and school level variables. "HLM is a powerful tool that permits a separation of within-school from between-school phenomena and allows simultaneous consideration of the effects of school factors not only on school means but also on structural relationships within schools" (Raudenbush and Bryk 1986, p. 13).

Rather than just focusing on race or gender or socioeconomic status, I will be looking at how these variables are also affected by tracking, the socioeconomic status of the school, whether the school is Catholic or public, and the percentage of minorities in a school. Any one of these variables could be expanded to a greater extent to explain an aspect of mathematics achievement. However, in this thesis I will be able to see how the context of the schools affect the students in those schools. This idea of context affecting the individual "is a defining claim of the sociological discipline, which is found in Marx's work on political economy (1846), in Durkheim's studies of the impact of community on anomie and suicide (1897), in Weber's research on how religious communities shape economic behavior (1905)" and so on and so forth (DiPrete and Forristal 1994, p. 331).

The central goals of my thesis will be: 1) determine to what extent individual level variables affect mathematics achievement, 2) consider how school level variables influence mathematics achievement and 3) observe cross-level interactions between the

individual and school level variables. This research is important, I feel, because often disparities in achievement are boiled down to one level of analysis. As we will later see, research tends to be focused either on student level characteristics or school level characteristics. My research will contribute to the body of educational literature in that it will offer an opportunity to consider several variables at once.

In the next chapter, I will review the relevant literature starting with sociological theories about education. Then I will examine the literature related to achievement and race, gender, socioeconomic status, tracking, and school type. Chapter III will discuss the data to be used in this thesis and further explain the methodology. In Chapter IV, the results of the modeling are discussed, as well as whether the hypotheses were upheld. Finally, in Chapter V, I discuss the implications of this research, areas for further study, and other conclusions are drawn.

CHAPTER II

REVIEW OF LITERATURE

In this chapter, I will review the relevant literature regarding education in general, as well as the various independent variables that are being tested in this study. Education is itself a broad subject area, as are the individual aspects outlined in the pages to follow. Any of these individual areas would require an extensive exploration of the literature. Because there are so many variables to consider, this review of the literature is meant to highlight major studies and thoughts in each area.

Theoretical Perspectives

There are many theoretical perspectives regarding education and its primary purpose. Some, such as Durkheim and Parsons, see education as an agent of socialization, preparing students for their future role in society. Others, including Bowles and Gintis (1976), Karabel and Halsey (1977), Michael Apple (1982; 1979), and Bourdieu and Passerson (1977) take a less functionalist view of education, claiming that its purpose is to reinforce and perpetuate the existing class structure. Theorists like Henry Giroux (1983), John Ogbu (1990), and Paul Willis (1977) have expanded on reproduction theory by adding the element of human agency. The resulting work in resistance theory adds to the literature by looking not just at student characteristics (as the functionalists have done) or at society (as reproduction theorists have), but also how the contexts of the school and the individual students interact. I will briefly outline each of these theoretical perspectives.

Functionalist Perspective

Functionalist theorists, like Emile Durkheim and Talcott Parsons, see education as a primary socializing agent. It is in schools where students learn what is expected of them when they interact with others in society and in their future roles. Durkheim defines education as

> the influence exercised by adult generations on those that are not yet ready for social life. Its object is to arouse and to develop in the child a certain number of physical, intellectual, and moral states which are demanded of him by both the political society…and the special milieu for which he is specifically destined (Durkheim 1956, p. 17).

He sees education as the outcome of "common life" in that what people learn in schools, the curriculum, and the student's aptitudes are meant to fit the needs of society. Society survives by having people fulfill various roles, from garbage man to doctor. All these people need a basic understanding of how society works and what is expected of them, which education provides.

Talcott Parsons shares this view of education and its purpose in society. He claims that students learn two roles in schools, their responsibility to society and their responsibility to the specific role they play in society.

> The socialization function may be summed up as the development in individuals of the commitments and capacities which are essential prerequisites of their future role-performance. Commitments may be broken in turn into two components: commitment to the implementation of the broad values of society and the commitment to the performance of a specific type of role within the structure of society (Parsons 1959, p. 217).

Reproduction theorists disagree with this view of schools and use the works of Marx to develop a new theoretical perspective. The focus is less on students and more on how schools are controlled by the interests of the dominant classes.

Reproduction Theory

This theoretical perspective focuses on how those with power in society use education to reproduce the social class structures of society in order to maintain and legitimize the existing system. "Public school systems existed to shape behavior and attitudes, alleviate social and family problems, and to improve poor people and reinforce a social structure under stress. The character of pupils assumed much more importance than their minds" (Katz 110, p. 1995). As Katz puts it, the focus of education is making students into what society needs them to be, not developing them as people. The purpose of education is to reproduce the status quo and is even a scapegoat for societal ills. Carnoy and Werthein concur with this view of education. "In fact, however, education is an ideological superstructure and is closely linked with the means of production…Throughout the whole history of human society education has been a product of the social classes which dominated at each stage…The content and orientation of education are therefore determined by the social classes which are in power" (Carnoy and Werthein 1977, p. 573).

Reproduction theory gets its start in Marxism and critical theory. Education is a necessary resource in order for some to gain access to the means of production. This system of credentialism in order to gain status in society creates a cycle of oppression that keep some in society at the bottom, while those at the top remain in control.

Additionally, as Collins (1971) suggests, the standards of education continually increase. "Once higher levels of education become recognized as an objective mark of elite status, and a moderate level of education as a mark of respectable middle-level status, increases in the supply of educated persons at given levels result in yet higher levels becoming recognized as superior, and previously superior levels become only average" (Collins 1971, p. 131). In order to explain how these patterns are reproduced in society and how some have access to higher levels of achievement while others do not, it is necessary to look more closely at reproduction theory. Reproduction theorists fall into two broad categories according to Giroux (1987), which are the economic-reproduction model and the cultural-reproduction model.

Economic-Reproduction Model

The economic-reproduction model considers how schools are tied to the economic system. They ask the questions of how schools influence students, and how the education system functions in society (Giroux 1983). Often the answers to these questions have to do with the educational process favoring upper-class students.

> Thus unequal education has its roots in the very class structure which it serves to legitimize and reproduce. Inequalities in education are thus seen as part of the web of capitalist society, and likely to persist as long as capitalism survives (Bowles 1971, p. 1).

This is not an optimistic view of the school system and the inequalities that exist. According to Giroux, both Baudelot and Establet concur with this view and add that the system must exist as it is in order to ensure that capitalism will be maintained.

> Baudelot and Establet also stress that the principal function of the school can only be understood in terms of the role it plays in the

> production of labor power, the accumulation of capital, and in the reproduction of legitimating ideologies (Giroux 1983, p. 265).

Tracking, which will be discussed in more detail later, is regarded as a method that is used in order to ensure that students fill their specific roles in the labor market. Not only that, but the system also is set up to legitimize existing structure.

Cultural-Reproduction Model

A major contributor to the cultural-reproduction model of education is Pierre Bourdieu. Bourdieu studied the French educational system, focusing on how the power elite influenced and controlled the school system. He maintained that the educational system reinforces and legitimates the cultural experiences of the dominant class. Specifically, Bourdieu claims that schools pay a role in sustaining power relations, through processes such as tracking, school culture, and instruction (Schwarz 1997). Bourdieu saw education as performing three basic functions:

(1) Education is "an institution specially contrived to conserve, transmit, and inculcate the cultural canons of a society" (Bourdieu 1971, p. 178).

(2) Education "reinforces rather than redistributes the unequal distribution of cultural capital" (Schwarz 1997, p. 191).

(3) Education "deflects attention from and contributes to the misrecognition of is social reproduction function" (Schwarz 1997, p. 191).

Michael Apple also contributes to the reproduction model, emphasizing that capitalist societies require "not the widespread distribution of high status knowledge to the populace in general" (Apple 1979, p. 37). Achievement from minorities and the working class is not regarded as being important, because their function in society is to

produce. Knowledge beyond this is unnecessary and therefore high achievement levels from these groups is not expected or encouraged (Lynch 1989). However, resistance theorists criticize reproduction theorists to the extent that within the reproduction framework students have no influence on the system. Resistance theorists agree that inequalities exist in the system, but believe that some students can see through the legitimization and resist it.

Resistance Theory

Often, when students deviate from what is expected, he or she is blamed or labeled, in order to understand and justify the behavior. Resistance theory looks at actions of deviation from what is expected as a response to the inequality at work in schools. The main idea of resistance theory is that students have agency and are not just pawns to be played by those who are dominant in the educational structure. There is a link between the structure and the student's agency. As Willis (1977), found however, at times, the way students resist the system ensures that they do not advance in the system, but maintain their status. "Class identity is not truly reproduced until it has properly passed through the individual and the group, until it has been recreated in the context of what appears to be personal and collective volition. The point at which people live, not borrow, their class destiny is when what is given is reformed, strengthened, and applied to new purposes" (Willis 1977, p. 2).

Giroux adheres to resistance theory but also makes suggestions on how to improve the theoretical framework. He has four basic criticisms of resistance theory.

(1) "What is missing in this perspective are analyses of those historically and culturally mediated factors that produce a range of oppositional behaviors, some of which constitute resistance and some of which do not" (Giroux 1983, p. 285). There is a need for clearer definitions of what resistance is and what it is not.

(2) The second criticism of resistance theory is that gender and race are often not taken into account in the discussion of what resistance actually is. Women and people of color view education and their acts of agency in a framework that is different than that of white males (Giroux 1983).

(3) The third criticism has to do with actions of resistance. Giroux points out that not all acts of resistance may have something to do with the dominant ideology of the school, but rather the school is the setting where resistance to other issues gets played out. Not all students act out when they realize the inequalities that are present in school. They may be aware of their class standing, but choose not to act rebelliously in response. This is another issue that is not adequately dealt with by resistance theorists according to Giroux (Giroux 1983).

(4) "A fourth weakness of theories of resistance is that they have not given enough attention to the issue of how domination reaches into the structure of personality itself" (Giroux 1983, p. 288). In other words, resistance theorists need to understand to a greater extent the psychology of oppression and how that affects students.

Regardless of these weaknesses in resistance theory, this theoretical perspective has added a great deal to our understanding of the education system. Clearly, there is more to understand in order to help students achieve in education while allowing their culture, ethnicity, gender, and socioeconomic status to be valued by the school system. This could mean changing the entire approach to education for our country and redefining what achievement means for each student in schools. In order to do this, there needs to be a basic understanding of what various students go through in schools.

Freire (1993) masterfully describes the conflict that students go through in the current education process.

> The oppressed suffer from the duality which has established itself in their innermost being…They are at one and the same time themselves and the oppressor whose consciousness they have internalized. The conflict lies in the choice between being wholly themselves or being divided; between ejecting the oppressor within or not ejecting them; between human solidarity or alienation; between following prescriptions or having choices; between being spectators or actors; between acting or having the illusion of acting through the action of the oppressors; between speaking out or being silent, castrated in their power to create and re-create, in their power to transform the world. This is the tragic dilemma of the oppressed which their education must take into account (Freire 1993, p. 30).

Oppressed students face huge hurdles compared to the experience that majority students must leap. Understanding this is a large aspect of making changes in the current educational system in order to ensure that all students are given equal opportunities to achieve.

Theoretical Framework

After reviewing the theories that shape the sociology of education, it seems appropriate that reproductive theory would guide this research. As we have seen in the previous chapter, education is under attack by the government and laws have been passed in order to improve the current situation. However, it is clear that efforts to reform education are at their roots based on the idea of maintaining the status quo and not allowing for true agency for students, schools, or parents.

> Critical educators oppose the deregulation and opening school success to the logic of the marketplace, supposedly through the new 'choice' schemes and voucher plans. Letting the market place 'equalize' education through vouchers will only exacerbate the disparity of chances between rich and poor students-inner-city schools will collapse. 'Choice' means that the poor are 'free' to become poorer while the rich are given the 'choice' of becoming richer…Choice

> schemes need to improve the conditions of low-performing schools or else state funding will shrink due to declining enrollments, and students and teachers will transfer to other schools (McLaren 1998, p. 168).

Additionally, it will not be possible in this study to measure student resistance based on the data that is being analyzed. I will be examining how mathematics achievement is affected by various independent variables, and by doing so we will be able to see how certain categories of students achieve.

It may be possible then for me to test the theory of reproduction. Is the educational system reproducing the status quo in society? Are certain students achieving more than others because of ascribed characteristics? Are others unable to achieve at the same level because of their gender or race or socioeconomic status? Or is everyone achieving at the same level regardless of his or her personal traits or the type of school they attend? This can be measured quantitatively which this thesis will do.

Some criticize reproduction theory as being too deterministic, implying that students cannot make change in the system as the resistance theorists suggest. However, Lareau suggests another framework to consider reproduction theory which involves moments of inclusion and exclusion. "We define moments of inclusion as the coming together of various forces to provide an advantage to the child in his or her life trajectory…In contrast, moments of exclusion may include placement in a low reading group, retention, placement in remedial courses, and the failure to complete college-preparation requirements" (Lareau 1998, p. 266). This approach does not determine paths in a definite way, but instead suggests that there are opportunities for some and not for others.

In order to take the next step and determine whether some students are not achieving because they are resisting the inequities in the system, it would be necessary to gather qualitative data as well. We can only assume low achievement could be related to resistance using quantitative data. Another methodology might make it possible to determine if students are underachieving by their own choice.

Achievement and Race

"On the whole, the basic academic achievement of black, Hispanic, American Indian, and some other minority students, particularly those from low-income families, has been significantly lower than that of the more affluent white Anglo-Saxon Protestant (WASP) students" (Brookover 1985, p. 257). As Brookover aptly states, there are discrepancies between how white students and non-white students achieve. Research on the achievement of minority groups often focuses on one of three factors: family background, socioeconomic status, and institutional discrimination. Other more radical research focuses on biological reasons for low achievement, suggesting that minorities are genetically inclined to perform at a lower level than the white majority (Herrnstein and Murray 1994). However, when considering race, one must also consider the contextual effects of the school.

Jencks and Phillips (1998) in their book *The Black-White Test Score Gap* emphasize the lack of evidence in proving any genetic cause of underachievement, but instead suggest that issues of culture and school could be the cause of the gap. Jencks and Phillips overlook societal causes of test score discrepancies, not focusing on the more structured discrimination that exists in society that will be discussed later on.

Their belief that "reducing the test score gap is probably both necessary and sufficient for substantially reducing racial inequality in educational attainments and earnings," and that "changes in education and earnings would in turn help reduce racial differences in crime, health, and family structure" may be placing too much emphasis on test scores and not enough on dealing with educational reform. (Jencks and Phillips 1998, p. 4)

Though segregation in education is illegal, many schools remain highly segregated, especially in the South and in urban areas. Schools that have a high concentration of minority students also tend to have students from low socioeconomic status. Because of this, parental involvement is lower, school resources are scarce, the student to teacher ratio tends to be high, and the mathematics achievement tends to be low (Roscigno 1998; Entwisle and Alexander 1992). Like women and lower socioeconomic status students, minority students are often tracked toward more vocational courses and discouraged from taking academic courses (Feagin 1978).

Furthermore, minority students have a more difficult time achieving social rewards for their achievement, regardless of gender or social class, which creates a disincentive to put forth effort in school. In other words, their minority status hinders their chance to advance in society and often their actual ability will is not considered. Because of this, students underachieve, knowing that the future for them is bleak (Kozol 1991).

Ogbu and Fordham (1986) have researched this issue. They have found that there is a belief, especially among African-Americans, that they will not receive returns for their educational achievement, and furthermore, they see achievement as something

that is valued by white culture. For some students, this results in a resistance to achievement or "acting white." Ogbu (1990) also makes the distinction between immigrant minority groups and involuntary minorities. He finds in his research that for immigrant minorities, minority status is not something they see as a hindrance to achievement.

For involuntary minorities however, they see their minority status as an identity distinct from the majority group in society, and therefore attempt to maintain this identity, by not engaging in activities that are considered "white" (Fordham and Ogbu 1986). "Generally, involuntary minorities have acquired a basic distrust for the public schools, and for school personnel, and they believe that they are provided with inferior education for no other reason than because they belong to involuntary minority groups" (Ogbu 1990, p. 54).

This is not to say however that all voluntary immigrants to the United States do not find obstacles related to their culture or their ethnicity. Often times, Latino students struggle in classrooms throughout the country on a level that is similar to African American students. These students are marginalized, often due to stereotypes or because of English language deficiencies. Schools do not often adapt to meet the needs of Latino students, and consequently, these students suffer. The dropout rate prior to 1998 for Hispanic students was at 30 percent according to a study by the American Association of University Women Educational Foundation (AAUW). This same study also indicated that Hispanic students do less well in school the longer that they live in the United States. "Soberingly, the dropout rate is worse among second-generation students than

those newly arrived, suggesting that the problem becomes more rather than less pronounced the longer families have been in the country, and is not exclusively a function of non-English speaking status" (American Association of University Women Educational Foundation 1999, p. 122). Schools are not designed to benefit Hispanic students. Other researchers have focused on how Latino students are impacted by the current emphasis on standardized tests that are being legislated by the federal government.

> The tests are an irritant; the 'high stakes' attached to them can be disastrous for Chicanos and other minority students. Student and teacher lives can be destroyed by these test results. Little has been done to equalize resources, or to make appropriate adaptations for English language learners. But more important than all of the concern about standardizing student activity is the undeniable fact that testing does not alter life chances any more than measuring temperature reduces fever (Pearl 2002, p. 348).

In other words, if Hispanic students do manage to achieve on standardized tests, despite the obstacles they face on a regular basis in schools, this does not mean that they will have a better chance of achieving greater outcomes when they leave high schools. The schools themselves may benefit from high scores, but the students are not guaranteed a better life as the above passage suggests. More often though, Hispanic students do not achieve at the same level as their white peers.

Not only do Latino students suffer from the push for high standardized test scores, but they, like their African American counterparts, are not highly represented in college-preparatory classes in public schools.

> Valencia performed 685 individual disparity analyses across the three types of courses [mathematics, science, and English] at each of the eight schools. He observed a *consistent, glaring, and strong pattern*: Chicano/other Latino students (as well as African Americans) were *overrepresented*-albeit a small

> number of exceptions-in the non-college preparatory courses and *underrepresented* in the college preparatory courses, particularly honors courses. By sharp contrast, White students showed the converse pattern (Valencia, Menchaca, and Donato 2002, p. 95).

As we will see later in this chapter, tracking has a huge affect on the path that students take in their academic careers. Minority students are being locked out of advanced coursework, which in turn affects their overall achievement in certain areas, and their possibility to continue their education after high school. This study shows how the education system is reproducing the status quo in society, ensuring that some (Whites) are able to advance when they leave high school, while others will surely be left behind.

Many researchers believe that the bleak future for minority students is directly related to racism that is inherent in the school system and even in society as a whole. "Public education represents a social sorting device stacked even more heavily against blacks than against the poor. Racism remains as integral and functional to public education as ever. An attitude that describes one group of people as essentially different from, and inferior to, the dominant group is racist…The racism implicit in the origins of public education became functional as an excuse for educational failure" (Katz 1975, pp. 110-111). Until racism is eradicated, it will be impossible for minority students to make the same kinds of gains in the educational process, because they will always be seen as different or even inferior (Feagin 1996).

The racism that guides this practice becomes covert, as educational failure is placed elsewhere. "The racism sometimes inherent in the environmentalist position (where environment is defined as the *family* context) is more subtle, and for that reason often more insidious…the general tone is pity for the deprived slum child, who lacks

opportunities to learn manners and morals, to see cows and trees, to learn long words and respect for education" (Katz 1975, pp. 110-111). Rather than addressing the bigger issues of what people with the power to change or create the educational system may believe about minorities, attention is focused on the individual student or that student's parents. This is why it is important to consider the context of where students learn when attempting to determine what causes disparities in achievement.

Achievement and Socioeconomic Status

Socioeconomic status is a very important factor when it comes to understanding mathematics achievement. It is often the case that students who are from a lower-class background are tracked based on their social status rather than on their actual ability. Class stratification in schools is seen by some as being rooted in society's capitalist ideals.

> Although the unequal distribution of political power serves to maintain inequalities in education, their origins are to be found outside the political sphere, in the class structure itself and in the class subcultures typical of capitalist societies. Thus unequal education has its roots in the very class structure which it serves to legitimize and reproduce (Bowles 1971, p. 137).

The educational system then serves to legitimize and reproduce existing inequalities. What this means for working class students is that they are often geared away from academic tracks and encouraged to pursue vocational courses (Feagin 1978; Oakes 1985). Many times, teachers have lower expectations of poor students which results in having lower expectations of their potential to achieve, and thus these students achieve less (Roscigno 1998). Bowles and Gintis (1976) claim that the reproduction of the division of labor in schools is based on what exists in society at large. "Specifically, the

relationships of authority, and control between administrators and teachers, teachers and students, students and students, and students and their work replicate the division of labor which dominates the work place" (Bowles and Gintis 1976, p. 12). This reproduction of the division of labor makes it very challenging for the educational system to be reformed.

In the book *Learning to Labor*, Willis (1977) studied working-class students in order to understand why they end up in working class jobs. The general conclusion is that working class students do not see how they can improve their social position through education and therefore resist high achievement. Schools have several means of stratifying education by social class including "tracking, differential participation in extracurricular activities, and in the attitudes of teachers and particularly guidance personnel who expect working class children to do poorly, to terminate schooling early, and to end up in jobs similar to their parents" (Bowles 1971, p. 143).

Annette Lareau (1987) studied parental involvement in schools based on social class. She found that working class parents were less likely to be involved in their student's education, because of their own level of schooling and their trust that teachers were taking care of the educational process. (Lareau 1987) Working class parents were thus thought of as uninterested in their children's education by the schools and teachers, which was not the case. Middle-class parents were more likely and more able to be involved in the schools their children attended in a variety of ways. "This study, however, suggests that middle-class families have cultural resources that become a form of cultural capital in specific settings" (Lareau 1987, p. 83). Lareau further suggests that

both working-class parents and middle-class parents have forms of cultural capital, but the cultural capital of the middle-class is more highly valued by the schools. What this means for working-class parents is that they are less likely to want to be involved in schools knowing their contributions are not as equally valued.

Generally, we can see that class matters when it comes to education. Upper class and middle-class students are better prepared for education, because of their status and the education and experience of their parents. Advancing in society, gaining social class status is also a highly coveted goal of our American culture. This focus on the almighty dollar has had negative consequences for women and minorities trying to achieve at the same levels as their majority counterparts. As bell hooks puts it:

> Ironically, the token presence of individual white women and people of color among the rich and powerful was effectively used to validate the existing social and economic structure by conservatives who had religiously fought to keep them out. By the early eighties, the ideas that sexism and racism had been eradicated, coupled with the assumption that the existing white supremacist capitalist patriarchy could work for everybody gained momentum and with it the notion that those groups for whom it did not work were at fault (hooks 2000, pp. 65-66).

Achievement and Gender

The gender gap between female and male achievement for the most part has closed. Females now achieve at levels that are equal to, or surpass, males in many subjects. Mickelson writes that this achievement is an anomaly considering that educational returns continue to favor men (Mickelson 1989). For other minority groups, the lack of returns can be a deterrent to achieving in school. However, for women, this has not been the case, for a variety of possible reasons, including the socialization of women's behavior in schools and women's beliefs that oppression is an issue of the past.

Most of the studies that have researched women's achievement in mathematics focus on socialization. Overall, women are not confident in their abilities in mathematics and tend to be directed towards other, more "feminine," areas (especially education and the social sciences). Most of the current research finds that women's achievement in mathematics is at the same level or exceeds male achievement, but that participation in careers related to mathematics is higher for men than for women (Catsambis 1994). Often, low achievement for women follows a pattern of socialization that has nothing to do with actual ability. Women are taught that they have a low aptitude for mathematics, which causes them to lose interest in the subject. From that point, women do not take as many mathematics courses, which also contributes to their low achievement.

Felson and Trudeau (1991) found in their research that socialization was not a strong indicator of mathematics achievement for girls. They showed that women achieved higher scores and put forth more effort in mathematics courses, though women earn lower scores in mathematics performance compared to other subjects. Women also scored lower than men on the SAT, which is inconsistent with their classroom performance. Their conclusion was that women experience "more anxiety about tests in general and that they have no special fear of mathematics" (Felson and Trudeau 1991, p. 120). They acknowledge that men tend to take more advanced level courses than women and that socialization could partially explain this. However, their final conclusion is that socialization alone is not enough to explain gender related achievement gaps.

"Unequal treatment and more subtle forms of classroom bias still discourage the achievement of girls and minorities, particularly in mathematics, science, and technology. Strategies that advance equity have potential to advance high standards for all students, but only if they are implemented with an understanding of specific groups' different classroom needs" (American Association of University Women Educational Foundation 1999, p. 61).

Achievement and Tracking

Tracking started in 1890s and has a long tradition in education. There is much debate surrounding the practice of tracking, with those who believe that it is an efficient way to organize schools and those who feel that it structures inequality. Jeannie Oakes (1985) notes some of the basic beliefs used to justify the practice of tracking.

(1) Remedial students hold high achieving students back and slow students do better when they are all grouped together.

(2) Slow students are more successful when they are not constantly reminded of their low ability, which is the case, when high ability students share their classes.

(3) Most people believe that placement systems are accurate and a fair reflection of students' past achievements and their abilities.

(4) It is easier for teachers to handle classes that have students at the same ability level rather than a mixed ability group (Oakes 1985).

Studies have refuted these assumptions however. Gamoran (1989) concludes that tracking reinforces inequalities between students, especially emphasizing differences between college track and non-college track students (Gamoran 1989).

Other student characteristics can affect a student's track placement, which can have a large impact on that student's options for the future. "The general conclusion that can be reached from this research is that tracking and ability grouping have a negative effect on the achievement of lower track or ability group students, a negligible effect on students in the middle groups, and a weak to modest positive effect on high track and ability group students" (Hallinan 1988, p. 260). Oakes also finds that tracking has negative effects for students and that placement into tracks is not a process that is accurate or fair. As discussed previously, working-class and minority students are more likely to be in low ability tracks than middle-class, white students. Specific to high-track mathematics classes, Oakes (1988) found in her work that an average of 60% of the students in these types of classes were white. She also reports that only 37% of the students in the low-track classes were white. This is one example of the disproportionate number of minorities in low-track classes.

Jones, Vanfossen, and Ensminger (1995) also studied the predictors of track placement for high school students. They too found disparities in how students were placed in academic tracks based on variables that include achievement and personal characteristics. "Students' chances of being in the academic track, rather than in the general track, rise as their grades, ability scores, SES origins, and educational experiences in the eighth grade increase, and if they are non-Hispanic, Black, or female" (Jones, Vanfossen, and Ensminger 1995, p. 292).

Jones, Vanfossen, and Ensminger also find that school level characteristics interact with individual characteristics when track placement is concerned. Therefore,

students with the same individual characteristics in different schools could find themselves in different tracks depending on the school-level characteristics (Jones, Vanfossen, and Ensminger 1995).

Gamoran's (1992) study suggests that varying tracking techniques can alter how students achieve and the environment in schools. "A more productive tracking system is one that results in higher average achievement than a less productive one…This means that, with given proportions of students in the different tracks, a more productive system must have a greater positive effect for high-track students, or a less negative impact for students in low tracks, or some combination" (Gamoran 1992, p. 813). He further suggests that Catholic schools are more productive in their tracking practices because of their tendency to be more focused on a college preparatory curriculum. Tracking is very important in that the track a student finds himself or herself in can have a big influence on future career options.

Achievement and Catholic Schools

Studies have shown that students who are enrolled in Catholic schools have higher achievement levels than students in public schools. Even Catholic school students who are not in the academic track are able to achieve at higher levels than their public school counterparts. "General track students in Catholic schools take a full year more of mathematics and almost a half year more of foreign language than do their public school counterparts" (Bryk, Lee, and Holland 1993, p. 104). Coleman, Hoffer, and Kilgore (1982) found in their research that sophomore students in private schools were at about the same level as senior students in public schools (Coleman, Hoffer, and Kilgore 1982).

Hoffer, Greeley, and Coleman report similar findings when comparing public and Catholic schools. Specifically they finds that minority students and poor students do especially well in Catholic schools compared to their public school counter parts. They find that these students are more likely to be placed in an academic track and even those who are not in an academic track achieve higher scores than students in public schools. The higher demand on students in Catholic schools is what is believed to be the reason for higher achievement in Catholic schools. It is the belief of Hoffer, Greeley, and Coleman that if public schools adopted policies that are similar to those in Catholic schools, they would find that their students would also achieve more (Hoffer, Greeley, and Coleman 1985).

In their analysis of both High School and Beyond Data and case studies of Catholic schools, Byrk, Lee, and Holland (1993) found that the educational mission of Catholic schools is one aspect of what allows for greater achievement in its students. "The central tenet of the academic organization of the Catholic high school is a core curriculum for all students, regardless of their personal background or future educational plans. This curriculum is predicated on a proactive view among faculty and administrators about what all students can and should learn. These beliefs connect to a long-standing Catholic tradition about what constitutes a proper humanistic education" (Bryk, Lee, and Holland 1993, p. 297). This practice has been found to be beneficial for students who would otherwise struggle in public schools.

The environment in these schools tends to be more egalitarian, where students who would normally be advantaged in public schools are not, and where poor and

minority students are given the same opportunities to achieve. "In sum, these analyses indicate that public high schools are more differentiating than are Catholic high schools in the backgrounds that students bring to their schools" (Lee and Bryk 1988, p. 90). Byrk, Lee, and Holland discuss that when educational reform was being discussed in the 1980s, many times Catholic schools where excluded from examination by task forces. "The omission is curious, because many of the recommendations being advanced for the reform of public education in the early 1980s had actually existed in Catholic schools for some time. Increasing academic course requirements for graduation, community service programs, and extending more control to individual schools, teachers, principals, and parents, for example, were already all common practices in Catholic school organization" (Bryk, Lee, and Holland 1993, p. 55).

One of the important aspects of Catholic education is the focus on academic requirements. Catholic schools in general have a greater percentage of students in the academic track and they often require more academic courses for graduation. This requirement applies to all students enrolled in the school, which means that everyone is receiving a more academically focused education. A very small percentage of students were found to be in vocational tracks in Catholic schools (Byrk, Lee, and Holland 1993). For students who come into Catholic schools less prepared than others, extra efforts are made so that they do not fall behind in their academics. Specifically for the subject of mathematics, Catholic educators have the goal "to move all students as far as possible through the traditional content of high school mathematics" (Byrk, Lee, and Holland

1993, p. 106). Clearly this goal is beneficial to students in Catholic schools, who achieve at greater levels than their public school counterparts.

Achievement and Racially Segregated Schools

Racially segregates schools provide their own challenges for achievement for disadvantaged students. Often, low socioeconomic status and high minority student populations coincide in schools, which can means that these schools have less resources and are less of a priority in communities. Research shows that racially segregated schools do affect achievement, especially for poor and minority students. Massey and Denton have done extensive work on residential segregation and they discuss how the concentration of poverty, in segregated areas can affect student achievement.

> But because poverty is associated with poor educational performance segregation also concentrates educational disadvantage. The organization of public schools around geographical catchment areas, in other words, reinforces and exacerbates the social isolation that segregation creates in neighborhoods. By concentrating low-achieving students in certain schools, segregation creates a social context within which poor performance is standard and low expectations predominate (Massey and Denton 1993, p. 141).

Jonathan Kozol's book *Savage Inequalities* goes into detail regarding how schools and students are affected by the social context of their schools. He finds that students in urban schools with a high percentage of minority students do not have the same basic opportunities as students in suburban mostly white schools. Because of how money is doled out to schools on the state and federal level, this segregation is perpetuated, making it difficult for urban schools to get by, while suburban schools are able to grow (Kozol 1991). This has an affect on segregated minority students and their motivation to succeed.

If we look at Chicano students specifically, we can see that segregation can be very detrimental.

> Findings from various studies and reports inform us that segregated Chicano schools tend to be schools characterized by a disproportionately high percentage of low-income students, low-funding, high dropout rates, low achievement test scores, few college preparatory courses, and low matriculation rates to college. There is no doubt that the isolation of Chicano students in schools that suffer from inequities in facilities, resources, and curricula offerings is far from desirable (Valencia, Menchaca, and Donato 2002, p. 83).

Segregated schools lack resources, funding, and attention from the public. As we have seen in other areas of this review of the literature, often times educational ideals are based on what the majority population deems important, therefore some students benefit while others do not. It is clear that segregation in education does not exist at the color line alone, but the socioeconomic differential between urban schools and suburban schools (the former usually being primarily minority students and the latter being primarily white) also creates discrepancies in the education that students receive.

In their residential segregation simulations, Massey and Denton were able to predict student achievement based on complete segregation and by varying the poverty rates for African Americans in the community. What they found was that residential segregation, and the resulting educational segregation that occurs, is detrimental for black students and their education is compromised because of this context.

> As the level of racial segregation increases, however, educational disadvantage is concentrated along with poverty. Given complete segregation between blacks and whites and a 20% rate of black poverty, our simulations predicts that children will attend high schools where 47% of the students score below 15th percentile on the CAT; and raising the rate of black poverty to 30% increases the percentage of low-scoring students to 58%. Segregation thus accounts for the difference between an educational environment where 65% of students score above the 15th percentile and one where 58% score below this cutoff. All other

> variables are held constant in the simulation, which suggests the great power of racial segregation to concentrate disadvantage on poor urban blacks (Massy and Denton 1993, pp. 141-142).

Though these numbers are based on a simulation, we have seen in other areas of the literature that race and poverty matter when it comes to educational attainment. It is important then to consider how the context of a school can affect a student's achievement in regard to the concentration of minority students in their school.

At the same time, it is critical to remember that when schools are integrated, challenges still exist for students of color. W.E.B. DuBois (1969) discussed a dual-identity that African Americans must deal with in society, where they have to both assimilate in order to get by in white society and hang onto dimensions of their own unique culture and ethnicity (Dubois 1969). The education system does not make this easy for African Americans and Latinos, in that the assimilation is often more important than retention of culture.

> School changed utterly with racial integration. Gone was the messianic zeal to transform our minds and beings that had characterized teachers and their pedagogical practices in our all-black schools. Knowledge was suddenly about information only. It had no relation to how one lived, behaved. It was no longer connected to antiracist struggle. Bussed to white schools, we soon learned that obedience, and not a zealous will to learn, was what was expected of us. Too much eagerness to learn could easily be seen as a threat to white authority (hooks 1994, p. 3).

While considering the context of schools, especially in regard to segregation, it is important to remember how the context can affect the student. Whether or not a minority student is bussed to a mostly white school or they are nested in a mostly minority school can have an affect on that student's educational experience and ultimately their educational outcomes.

As we can see from this literature review, there are patterns of underachievement for some students based on characteristics other than their intelligence or ability. The factors that create this disadvantage for some students exist at both the individual student level and the school level. We have seen through the literature how the educational system often reproduces the status quo, so that those who are held back by their race or socioeconomic status in society, are also held back by similar characteristics in schools. We will see throughout the rest of this thesis how reproduction theory is at work in this data set. After this review of the literature, it is necessary to consider the variables in this research, the hypotheses that will be tested which come from the literature we have just reviewed, as well as the methodology, which the next chapter will begin to do.

CHAPTER III

DATA, METHODOLOGICAL PROCEDURES, AND HYPOTHESES

In this chapter, I first describe the data set that will be used in this thesis. I next discuss the dependent variable, mathematics achievement, and the various student level and school level independent variables. Next, the Hierarchical Linear Model (HLM) used in this study will be explained in terms of the methodology itself, as well as what the model will entail. Finally, I end the chapter by discussing the hypotheses that guide this study.

Description of the Data

The data utilized in this analysis come from the 1982 High School and Beyond Survey. The High School and Beyond survey was made up of two cohorts of students, the 1980 senior class and the 1980 sophomore class. The two groups were surveyed every two years from 1980 until 1986, with an additional survey for the sophomore group in 1992. This study was originally designed in response to an earlier study of schools completed by the National Center for Educational Statistics (NCES) in 1972, which was called the National Longitudinal Study of the High School Class of 1972. The High School and Beyond survey sought to expand on the information gathered by the NCES, by including the two different cohorts, which provided data for two sets of students allowing them to study drop-out rates and changes that students experience throughout their time in high school. The subset of data used in this thesis consists of 7,185 students who are nested in 160 high schools in the United States. Of these

schools, 90 of them are public, and 70 of them are private Catholic schools (Bryk, Lee, and Holland 1993, p. 61).

Definition of Dependent Variable

The dependent variable is the mathematics achievement scores of the students in the 160 schools. Mathematics achievement is a measure of an individual student's mathematics achievement in their senior year. Lee and Bryk (1989) explain that mathematics achievement is a desired focus of student achievement, because "(1) mathematics is the academic area most influenced by schooling and least affected by home factors (Murnane 1975), (2) mathematics is the longest and most reliable of the six HS&B (High School and Beyond) achievement tests (Heyns & Hilton 1982), and (3) the best information about specific courses students have taken is available in this subject area" (Lee and Bryk 1989, p.179).

Description of Independent Variables

Table 1 presents the eight independent variables that are included in my thesis. Some are measured at the level of the individual student, and others are measured at the level of the school. They are the following:

Level 1 Variables-Individual Characteristics

(1) Female

This is a dummy variable where 1=female and 0=male.

(2) Race

This is a dummy variable in which students are coded 1 if they identify as black or Hispanic, and 0 if they identify as anything else (Bryk and Raudenbush, 1992).

Grouping Hispanic and African American students together in this variable is not idea and it would be more useful to have individual variables for each of these groups of students. The choice to group the data together was made by the researchers who constructed the data set, which is why the variable is constructed as it is.

(3) SES

This variable is a standardized variable determined from characteristics of the students' parents. This SES scale includes various aspects of socioeconomic status, such as the parents' education level, occupation, and income.

Level 2 Variables-School Characteristics

(1) High minority percentage (HIMINTY)

This is a measure of the percentage of minorities enrolled in an individual school. This is a dummy variable where 1= more than 40% minority enrollment and 0= less than 40% minority enrollment. Lee and Bryk explain that

> the decision to dichotomize the variable representing the proportion of minority students enrolled in each school was made because of the distinctly nonnormal distribution of this variable. We decided, on the basis of exploratory analyses, on a 'break point' of 40 percent, since the relationship of average school outcomes to minority concentrations appeared to change at that point. Furthermore, few schools had minority enrollment in the middle ranges. Thus the split at 40 percent basically separates the all-minority schools (Lee and Bryk 1989, p. 181).

(2) Academic Tracking (PRACAD)

This is a school level measure of the proportion of students in an academic track in each school.

(3) School Type (SECTOR)

This variable measures whether or not a school is a private Catholic school or a public school where Catholic=1 and public =0.

(4) Mean SES (MEANSES)

This variable is a measure of the mean SES of the school based on the SES scores of the students.

Table 1. Description and Coding Schemes for Variables

Variable	Description of Variable and Coding
FEMALE	Dummy variable where 0=Male; 1=Female
MINORITY	Dummy variable where 0=Non-minority; 1= African American or Hispanic student
SES	Composite of parental education, parental occupation, and income
HIMINTY	Dummy variable where 0=school with less than 40% minority student population; 1=school with over 40% minority student population
PRACAD	Proportion of students in the academic track
SECTOR	Dummy variable where 0=public school; 1= Catholic school
MEANSES	Mean of the SES values for the students in a school

The Hierarchical Linear Model

For this research, hierarchical linear models (HLM) will be estimated. HLM provides an opportunity to analyze whether cross-level variation exists between the school level characteristics and the student level characteristics. HLM also allows me to focus on the individual and the school level main effects on mathematics achievement. My research acknowledges that there are relationships between individuals and their mathematics achievement, as well as relationships between the schools and mathematics achievement.

By using HLM methodology, I will be able also to see if individual effects are influenced by school level effects. It is useful therefore to consider both levels of analysis at once, which is what HLM allows us to do. One should not assume however that because both of these levels of analysis are related in some ways that we can aggregate or disaggregate the variables considered. To do so would mean to lose the effectiveness of the variables considered in the thesis and to generalize characteristics, which may not truly represent either the schools or the individuals. HLM allows us to utilize both school level and individual level effects without the need to aggregate or disaggregate the data.

The basic analysis is informed by structural models at two levels. At the individual (or student) level, the structural models is:

$$Y_{ij} = B_{0j} + B_{1j}X_{1i} + B_{2j}X_{2i} + B_{3j}X_{3i} + r_{ij}$$

- Where Y_{ij} is the mathematics achievement score of the i^{th} student in the j^{th} school.
- X_{1i} is the student's gender.

- X_{2i} is the student's race.
- X_{3i} is the student's socioeconomic status.
- B_{0j}, B_{1j}, B_{2j}, and B_{3j} are the regression coefficients
- r_{ij} is an error term unique to the i^{th} student in the j^{th} school.

The structural model at the school level consists of the following equations:

Model1:

$$B_{0j} = \gamma_{00} + \gamma_{01}(\text{PRACAD}) + \gamma_{02}(\text{HIMINTY}) + u_{0j}$$
$$B_{1j} = \gamma_{10} + \gamma_{11}(\text{PRACAD}) + \gamma_{12}(\text{HIMINTY}) + u_{1j}$$
$$B_{2j} = \gamma_{20} + \gamma_{21}(\text{PRACAD}) + \gamma_{22}(\text{HIMINTY}) + u_{2j}$$
$$B_{3j} = \gamma_{30} + \gamma_{31}(\text{PRACAD}) + \gamma_{32}(\text{HIMINTY}) + u_{3j}$$

- Where PRACAD is the proportion of students in the academic track.
- Where HIMINTY is the percentage of minority students in a school.
- Where $\gamma_{01}, \gamma_{11}, \gamma_{21}, \gamma_{31}$ are the average PRACAD-mathematics slopes across the schools.
- Where $\gamma_{02}, \gamma_{12}, \gamma_{22}, \gamma_{32}$ are the average HIMINTY-mathematics slopes across the schools.
- Where γ_{00} is the average of the school means on mathematics achievement across the schools.
- Where u_{0j} is the unique increment to the intercept associated with school *j*.
- Where u_{1j}, u_{2j}, u_{3j} are the unique increments to the slopes associated with school *j*.

Model2 :

$B_{0j} = \gamma_{00} + \gamma_{01}(SECTOR) + \gamma_{02}(MEANSES) + u_{0j}$

$B_{1j} = \gamma_{10} + \gamma_{11}(SECTOR) + \gamma_{12}(MEANSES) + u_{1j}$

$B_{2j} = \gamma_{20} + \gamma_{21}(SECTOR) + \gamma_{22}(MEANSES) + u_{2j}$

$B_{3j} = \gamma_{30} + \gamma_{31}(SECTOR) + \gamma_{32}(MEANSES) + u_{3j}$

- Where SECTOR is whether the school is Catholic or public.
- Where MEANSES is a measure of the average socio-economic status of the school
- Where $\gamma_{01,}\gamma_{11}$, γ_{21} , γ_{31} are the average SECTOR-mathematics slope across the schools.
- Where $\gamma_{02,}\gamma_{12}$, γ_{22} , γ_{32} are the average MEANSES-mathematics slope across the schools.
- Where γ_{00} is the average of the school means on mathematics achievement across the schools.
- Where u_{0j} is the unique increment to the intercept associated with school *j*.
- Where u_{1j}, u_{2j}, u_{3j} are the unique increments to the slopes associated with school *j*.

Model3 :

$B_{0j} = \gamma_{00} + \gamma_{01}(SECTOR) + \gamma_{02}(HIMINTY) + u_{0j}$

$B_{1j} = \gamma_{10} + \gamma_{11}(SECTOR) + \gamma_{12}(HIMINTY) + u_{1j}$

$B_{2j} = \gamma_{20} + \gamma_{21}(SECTOR) + \gamma_{22}(HIMINTY) + u_{2j}$

$B_{3j} = \gamma_{30} + \gamma_{31}(SECTOR) + \gamma_{32}(HIMINTY) + u_{3j}$

- Where SECTOR is whether the school is Catholic or public.
- Where HIMINTY is the percentage of minority students in a school.

- Where $\gamma_{01}, \gamma_{11}, \gamma_{21}, \gamma_{31}$ are the average SECTOR-mathematics slopes across the schools.
- Where $\gamma_{02}, \gamma_{12}, \gamma_{22}, \gamma_{32}$ are the average HIMINTY-mathematics slope across the schools.
- Where γ_{00} is the average of the school means on mathematics achievement across the schools.
- Where u_{0j} is the unique increment to the intercept associated with school *j*.
- Where u_{1j}, u_{2j}, u_{3j} are the unique increments to the slopes associated with school *j*.

The following equations are the main HLM equations to be estimated:

Model1

$$Y_{ij} = \gamma_{00} + \gamma_{01}(PRACAD)_j + \gamma_{02}(HIMINTY)_j + \gamma_{10}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + \gamma_{11}(PRACAD)_j(FEMALE_{ij} - \overline{FEMALE_{.j}}) + \gamma_{12}(HIMINTY)_j(FEMALE_{ij} - \overline{FEMALE_{.j}}) + \gamma_{20}(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{21}(PRACAD)_j(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{22}(HIMINTY)_j(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{30}(SES_{ij} - \overline{SES_{.j}}) + \gamma_{31}(PRACAD)_j(SES_{ij} - \overline{SES_{.j}}) + \gamma_{32}(HIMINTY)_j(SES_{ij} - \overline{SES_{.j}}) + u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$$

This equation will predict the dependent variable (Y_{ij}), mathematics achievement, as a function of:

- the overall intercept, γ_{00}, which in this case is the grand mean of math achievement across the 160 schools,

- the main effect of the proportion of students in an academic track (PRACAD), γ_{01}
- the main effect of the minority concentration in a school (HIMINTY), γ_{02},
- the main effect of the student's minority status (RACE), γ_{10},
- the main effect of the student's sex (FEMALE) γ_{20},
- the main effect of the student's SES level (SES), γ_{30},

and the following cross-level interactions involving

- PRACAD with RACE, γ_{11},
- HIMINTY with RACE, γ_{12}
- PRACAD with FEMALE, γ_{21}
- HIMINTY with FEMALE, γ_{22}
- PRACAD with SES, γ_{31}
- HIMINTY with SES, γ_{32}

and a random error,

- $u_{0j} + u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}$ $(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$

Model2

$$Y_{ij} = \gamma_{00} + \gamma_{01}(SECTOR)_j + \gamma_{02}(MEANSES)_j + \gamma_{10}(FEMALE_{ij} - \overline{FEMALE_{.j}}) +$$
$$\gamma_{11}(SECTOR)_j(FEMALE_{ij} - \overline{FEMALE_{.j}}) + \gamma_{12}(MEANSES)_j(FEMALE_{ij} - \overline{FEMALE_{.j}})$$
$$+ \gamma_{20}(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{21}(SECTOR)_j(RACE_{ij} - \overline{RACE_{.j}}) +$$
$$\gamma_{22}(MEANSES)_j(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{30}(SES_{ij} - \overline{SES_{.j}}) +$$
$$\gamma_{31}(SECTOR)_j(SES_{ij} - \overline{SES_{.j}}) + \gamma_{32}(MEANSES)_j(SES_{ij} - \overline{SES_{.j}})$$
$$+ u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}$$
$$(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$$

This equation will predict the dependent variable (Y_{ij}), mathematics achievement, as a function of:

- the overall intercept, γ_{00}, which in this case is the grand mean of math achievement across the 160 schools
- the main effect of the main effect of whether a school is Catholic or non-Catholic (SECTOR), γ_{01}
- the main effect of the mean socioeconomic status of the school (MEANSES), γ_{02},
- the main effect of the student's minority status (RACE), γ_{10},
- the main effect of the student's sex (FEMALE), γ_{20},
- the main effect of the student's SES level (SES), γ_{30},

and the following cross-level interactions involving

- SECTOR with RACE, γ_{11},
- MEANSES with RACE, γ_{12}
- SECTOR with FEMALE, γ_{21}

- MEANSES with FEMALE, γ_{22}
- SECTOR with SES, γ_{31}
- MEANSES with SES, γ_{32}

and a random error,

$$u_{0j} + u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}$$
$$(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$$

Model3

$$Y_{ij} = \gamma_{00} + \gamma_{01}(SECTOR)_j + \gamma_{02}(HIMINTY)_j + \gamma_{10}(FEMALE_{ij} - \overline{FEMALE_{.j}}) +$$
$$\gamma_{11}(SECTOR)_j(FEMALE_{ij} - \overline{FEMALE_{.j}}) + \gamma_{12}(HIMINTY)_j(FEMALE_{ij} - \overline{FEMALE_{.j}})$$
$$+ \gamma_{20}(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{21}(SECTOR)_j(RACE_{ij} - \overline{RACE_{.j}}) +$$
$$\gamma_{22}(HIMINTY)_j(RACE_{ij} - \overline{RACE_{.j}}) + \gamma_{30}(SES_{ij} - \overline{SES_{.j}}) +$$
$$\gamma_{31}(SECTOR)_j(SES_{ij} - \overline{SES_{.j}}) + \gamma_{32}(HIMINTY)_j(SES_{ij} - \overline{SES_{.j}})$$
$$+ u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}$$
$$(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$$

This equation will predict the dependent variable (Y_{ij}), mathematics achievement, as a function of:

- the overall intercept, γ_{00}, which in this case is the grand mean of math achievement across the 160 schools
- the main effect of the main effect of whether a school is Catholic or non-Catholic (SECTOR), γ_{01}
- the main effect of the minority concentration in a school (HIMINTY), γ_{02},
- the main effect of the student's minority status (RACE), γ_{10},
- the main effect of the student's sex (FEMALE), γ_{20},

- the main effect of the student's SES level (SES), γ_{30},

and the following cross-level interactions involving

- SECTOR with RACE, γ_{11},
- HIMINTY with RACE, γ_{12}
- SECTOR with FEMALE, γ_{21}
- HIMINTY with FEMALE, γ_{22}
- SECTOR with SES, γ_{31}
- HIMINTY with SES, γ_{32}

and a random error, $u_{0j} + u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$

The error statements for each of these equations are significant, because the errors are dependent within each of the schools in the data set, and we can also see that there are unequal variances in the error term. This is due to the fact that the error term $(u_{0j} + u_{1j}(FEMALE_{ij} - \overline{FEMALE_{.j}}) + u_{2j}(RACE_{ij} - \overline{RACE_{.j}}) + u_{3j}(SES_{ij} - \overline{SES_{.j}}) + r_{ij}$ depends on u_{0j}, u_{1j}, u_{2j}, and u_{3j} which vary across schools and $(FEMALE_{ij} - \overline{FEMALE_{.j}})$, $(RACE_{ij} - \overline{RACE_{.j}})$, and $(SES_{ij} - \overline{SES_{.j}})$ which varies across students. This error term is ideal for this research because it takes into account both levels of analysis and the variation that exists. This kind of error equation would not be possible using Ordinary Least Squares (OLS) regression because OLS requires that the error terms be independent, have constant variance, and be normally distributed.

Hypotheses

I have developed several hypotheses that will be tested in this thesis. Each of these hypotheses is drawn from the literature that I have reviewed to inform the thesis, which was elaborated upon more fully in the previous chapter. Specifically, the hypotheses are:

1. Students' socioeconomic status is positively associated with mathematics achievement, when the other independent variables are held constant.
2. Compared to majority students, minority students should not perform as well in mathematics, controlling for the other independent variables.
3. Compared to male students, female students should not perform as well in mathematics, controlling for the other independent variables.
4. Schools with a higher proportion of students in the academic track will have higher mathematics achievement than schools with a lower proportion of students in the academic track, holding other independent variables constant.
5. Schools with over 40% minority students will have lower mathematics achievement than schools with less than 40% minority students, holding the other independent variables constant.
6. Catholic schools will have higher mathematics achievement scores than non-Catholic schools, when controlling for all the other independent variables.
7. Schools with a high mean-SES will have higher mathematics achievement than schools with a low mean-SES, when controlling for the other independent variables.

8. The advantageous effect (slope) of socioeconomic status on mathematics achievement will be less in Catholic schools than in non-Catholic schools, controlling for the other independent variables.
9. The disadvantageous effect (slope) of minority status on mathematics achievement will be less in Catholic schools than in non-Catholic schools, when controlling for the other independent variables.
10. The disadvantageous effect (slope) of female on mathematics achievement will be less in schools with a high proportion of students in the academic track than in schools with a low proportion of students in the academic track, when controlling for the other independent variables.

In this chapter I have described the data set that will be used in this thesis. The dependent variable has been defined, as have the independent variables that will be used both at the student level and the school level. I have also shown that HLM is an appropriate statistical model to use for my thesis, while also describing the details of the model in reference to the variables being used in this research. Finally, I have proposed hypotheses based on my review of relevant literature. In the next chapter, I will analyze the results of the HLM analysis in order to see how well the hypotheses did in predicting mathematics achievement.

CHAPTER IV

ANALYSIS OF DATA

In this chapter, I first describe in some detail the sample used in this analysis. Then I discuss why it is necessary to have three separate models in my thesis. Next I consider the results of each of the three models, in order to see if the hypotheses proposed in the previous chapter are supported. I also consider relationships that were similar in all three of the models in this analysis.

Description of Sample

As discussed earlier, data for this study come from the High School and Beyond Survey. Before examining the Hierarchical Linear Model output and how the hypotheses fared, it is important to look first at descriptive statistics about the two samples. These are shown in Table 2.

Table 2. Descriptive Statistics of Sample Used in Study

Variables	N	MEAN	SD	MIN	MAX
MINORITY	7185	.27	.45	0.00	1.00
FEMALE	7185	.53	.50	0.00	1.00
SES	7185	.00	.78	- 3.76	2.69
MATHACH	7185	12.75	6.88	- 2.83	24.99
SECTOR	160	.44	.50	0.00	1.00
PRACAD	160	.51	.26	0.00	1.00
HIMINTY	160	.28	.45	0.00	1.00
MEANSES	160	0.00	.41	- 1.19	.83

There are 7,185 students included in the Level 1 data. As shown in Table 2, 27% of the students are classified as minority, which includes African American and Hispanic identified students. Fifty-three percent of the students are women. The mean mathematics achievement score for the sample is 12.75, with a standard deviation of 6.9.

The Level 2 data consist of 160 schools. Of these, 44% are Catholic schools. Twenty-eight percent of the schools are identified as having a high proportion of minority students (over 40%).

Analysis of Variance

To begin this analysis, it is first important to conduct an analysis of variance (ANOVA). This test will enable me to "determine the total amount of variability in the outcome (senior-year mathematics achievement) within and between schools" (Byrk and Raudenbush 1992, p. 104). If the school level variance does not equal zero, then we know that multilevel modeling is an appropriate methodology. At the student level, the variance is 39.15 (σ^2) and at the school level the variance of the true school means around the grand mean, is 8.61 (τ_{00}). This indicates that most of the variance in mathematics achievement occurs at the student level (within schools) as opposed to the school level (between schools). (See Table 3.)

By calculating the intra-class correlation, that is, $\rho=\tau_{00}/\tau_{00}+\sigma^2$, $\rho=8.61/(8.61 + 39.15)$, we find that $\rho= .18$. In other words, 18% of the variance in mathematics achievement occurs between schools and 82% occurs within schools. The ANOVA test also provides a reliability estimate of .901, which indicates that the sample means are quite reliable in predicting the true means. This is good news for my model. The chi-

squared value (χ^2) tests the null hypothesis that all the school means are the same. The null hypothesis is rejected; χ^2 equals 1660.23 with 159 degrees of freedom, which indicates there is a significant amount of variation in mathematics achievement between schools, thus justifying my decision to model mathematics achievement with a multi-level approach.

Table 3. Results of Analysis of Variance

Estimated Effects				
	Gamma Coefficients	Standard Error	t-ratio	p-Value
Grand Mean Achievement Mean G_{00}	12.64	.0244	51.704	0.00

The Chi-Squared Table				
	Estimated Parameter Variance	Degrees of Freedom	Chi-Square	p-Value
Mean Achievement at Level 2 U_o	8.614	159	1660.233	0.00
Mean Achievement at Level 1	39.148			

Reliability of School-level Effects
Mean Achievement =.901

Testing for Collinearity

Another task is to assess whether or not any of the independent variables are highly related to each other. When variables are correlated it can affect their ability to predict the dependent variable because the variables are interacting with each other. It is important to test for relationships among the independent variables, so that we are sure

that the model is producing precise estimates. Additionally, when there is high collinearity, standard errors also tend to be high.

Table 4a. Correlation Matrix of Level 2 Variables

	SECTOR	PRACAD	HIMINTY	MEANSES
SECTOR	.4976			
PRACAD	**.6724**	.2559		
HIMINTY	.0494	-.0792	.4479	
MEANSES	.3553	**.6491**	-.4056	.4140

Table 4b. Correlation Matrix of Level 1 Variables

	MEANS	MINORITY	FEMALE	SES
MEANS	3.1177			
MINORITY	.1238	4.2846		
FEMALE	-.0639	.0978	2.1522	
SES	.0135	**-.5121**	-.2078	1.6310

Table 4.a shows zero-order correlations among the Level-2 variables. We can see that there is a need to separate the variables into different models. There is a strong

relationship between the PRACAD and MEANSES variables and between PRACAD and SECTOR. Because of collinearity, I decided to divide the level 2 variables into three separate models. The first model includes the PRACAD and HIMINTY variables. The second model includes the SECTOR and MEANSES variables. The third model includes the SECTOR and HIMINTY variables. We will later explore the significance of the correlations between two of the level 1 variables shown in Table 4.b.

Table 5. HLM Results for Model 1

	Effect	S.E.	*z* statistic
Fixed effects			
Mean achievement (γ_{00})	12.608	.093	135.644
Mean minority achievement slope (γ_{10})	-3.053	.266	-11.471
Mean female-achievement slope (γ_{20})	-1.099	.191	-5.755
Mean SES-achievement slope (γ_{30})	1.909	.120	15.893
Effects of between school variables			
PRACAD effects on			
mean achievement (γ_{01})	7.808	.369	21.176
minority-achievement slope (γ_{11})	2.529	.994	2.543
female-achievement slope (γ_{21})	.896	.829	1.081
SES-achievement slope (γ_{31})	-1.014	.485	-2.089
HIMINTY effects on			
mean achievement (γ_{02})	-2.359	.208	-11.351
minority-achievement slope (γ_{12})	.335	.534	.627
female-achievement slope (γ_{22})	.207	.441	.471
SES-achievement slope (γ_{32})	-0.935	.264	-3.546

Model One

Model One includes all three student level variables and two of the school level variables (PRACAD and HIMINTY). As discussed in the last chapter, PRACAD is the

proportion of students in the academic track and HIMINTY is whether or not the school has a minority population of over 40%. To begin this analysis of Model One, I will first look at the direct effect of the student level variables. (See Table 5) In this model, minority status, γ_{10}, is negatively related to mathematics achievement. In other words, when a student belongs to a minority group, his/her mathematics achievement score is 3.05 points lower than white students (t=-11.48). Women have mathematics achievement scores that are 1.09 points lower than men's scores (t=-5.76). Another direct effect on the student level has to do with a student's socioeconomic status. As a student's SES increases, γ_{30}, their mathematics score also increases 1.91 points compared to students with lower SES (t=15.89). It is evident then that student level variables do affect mathematics achievement scores, and that those effects are very significant.

Next, I will consider the direct effects of the school level variables. In Table 5 we see that PRACAD is positively related to mathematics achievement and it is a highly significant relationship (γ_{11} =7.81, t=21.18). What this means is that as the proportion of students in the academic track increases, mathematics achievement increases by .08 points. We also see a significant negative relationship between the percentage of minority students in a school and mathematics achievement. When schools are over 40% minority, the mathematics achievement score is 2.3 points lower than in schools that are under 40% minority (γ_{02} = -2.26, t=-11.35).

In looking at cross level interactions, I first consider the proportion of students in the academic track variable and how that affects the various mathematics achievement

slopes. When PRACAD increases by .01 unit, the minority-mathematics achievement slope increases by .02 (γ_{11} , t=2.54). Therefore, in schools with a large proportion of students in the academic track, the disadvantageous effect of minority status declines. The female-mathematics slope, γ_{21} , is affected by the PRACAD variable in a similar manner, however, this relationship is not statistically significant (t=.89). Finally, when PRACAD increases by .01 unit, the SES-mathematics achievement slope decreases by .01 (γ_{31} , t=-2.09). In other words, SES is converted into mean mathematics achievement in schools with a high proportion of students in the academic track at a rate that is .01 lower than in schools with a lower proportion of students in the academic track.

Next I will consider the cross level interactions between the student level variables and the percentage of minorities variable (HIMINTY). Schools with a minority population that is over 40 percent have an SES-mathematics achievement slope that is weaker than schools with a minority student population that is under 40% (γ_{22}=-.94, t=-3.55). In high minority schools, mean SES is converted into mean mathematics achievement at a rate that is .94 lower than in low minority schools. As we see in Table 4.b, there is a moderate negative correlation between the MINORTY and SES variables (-.5121). This indicates that it is likely that schools with a high percentage of African American and Hispanic students have lower SES than mostly white schools. Both the FEMALE-mathematics slope (γ_{22})and the MINORITY-mathematics (γ_{12}) slope increase slightly in schools with over 40% minority populations, however neither of these results were statistically significant.

Table 6. HLM Results for Model 2

	Effect	S.E.	*z* statistic
Fixed effects			
Mean achievement (γ_{00})	12.639	.088	143.548
Mean minority achievement slope (γ_{10})	-3.035	.262	-11.590
Mean female-achievement slope (γ_{20})	-1.097	.195	-5.622
Mean SES-achievement slope (γ_{30})	1.897	.119	15.884
Effects of between school variables			
SECTOR effects on			
mean achievement (γ_{01})	1.254	.188	6.663
minority-achievement slope (γ_{11})	2.299	.554	4.148
female-achievement slope (γ_{21})	.397	.464	.855
SES-achievement slope (γ_{31})	-1.279	.255	-5.016
MEANSES effects on			
mean achievement (γ_{02})	5.240	.227	23.046
minority-achievement slope (γ_{12})	-.473	.670	-.706
female-achievement slope (γ_{22})	.091	.544	.167
SES-achievement slope (γ_{32})	1.011	.317	3.193

Model Two

In this model the level two variables included are SECTOR (whether the school is Catholic or public) and MEANSES (mean values of the students SES values in a school). (See Table 6.) Again it is important to first consider the direct effects of the student level variables. As we saw in Model One, minority status is negatively related to mathematics achievement. Minority students' mathematics achievement scores are 3.04 points lower than white students' scores (γ_{10}, t=-11.59). Female students' mathematics achievement is 1.09 points lower than male scores (γ_{20}, t=-5.62). Finally, as socioeconomic status increases a students' mathematics achievement increases by 1.90 points (γ_{30}, t=15.88). As we can see from the t-ratios, these relationships are highly significant.

Table 6 shows us that as school MEANSES increases, the mean mathematics achievement also increases by 5.24 (γ_{02}, t=23.05). We also see that Catholic schools' have higher mean mathematics achievement than public schools; specifically Catholic schools have a mean mathematics achievement is 1.25 points higher than in public schools (γ_{01}, t=6.66).

It is apparent when examining the cross-level interactions that Catholic schools have an equalizing affect in regards to how students achieve in mathematics, in that students who would be disadvantaged because of their individual characteristics are less disadvantaged in Catholic schools. Also, those who would be more advantaged in public schools are less advantaged in Catholic schools. For example, in Catholic schools, the MINORITY-mathematics achievement slope increases by 2.3 compared to public schools (γ_{11}, t=4.15). In other words, the disadvantageous effect of being a minority in a public school is less in Catholic schools. We see a similar affect for female students in Catholic schools, (γ_{21}); however, this effect is not statistically significant. Additionally, in Catholic schools, the SES-mathematics achievement slope decreases, meaning that in these schools, SES is converted into mathematics achievement at a rate that is 1.27 lower than in public schools (γ_{31}, t=-5.02). Students who would normally be advantaged by high SES in public schools will not be as advantaged in Catholic schools.

As MEANSES increases, the minority-mathematics achievement slope (γ_{12}) and the female-mathematics slope both increase. However, neither of these results are statistically significant. There is a slight positive effect on the SES-mathematics

slope, γ_{32}, meaning that as schools SES increases, student SES is converted into mathematics achievement at a rate that is 1.01 higher than in schools with lower SES.

Table 7. HLM Results for Model 3

	Effect	S.E.	*z* statistic
Fixed effects			
Mean achievement (γ_{00})	12.611	.102	123.784
Mean minority achievement slope (γ_{10})	-3.100	.266	-11.634
Mean female-achievement slope (γ_{20})	-1.074	.194	-5.526
Mean SES-achievement slope (γ_{30})	1.895	.119	15.868
Effects of between school variables			
SECTOR effects on			
mean achievement (γ_{01})	2.932	.204	14.364
minority-achievement slope (γ_{11})	2.145	.518	4.142
female-achievement slope (γ_{21})	.455	.405	1.123
SES-achievement slope (γ_{31})	-.950	.240	-3.960
HIMINTY effects on			
mean achievement (γ_{02})	-2.831	.228	-12.440
minority-achievement slope (γ_{12})	.215	.533	.403
female-achievement slope (γ_{22})	.189	.435	.435
SES-achievement slope (γ_{32})	-.877	.262	-3.348

Model Three

Model Three (Table 7) includes the level two variables HIMINTY and SECTOR. Although we have seen both of these variables in the previous models, they behave somewhat differently in this model. The direct effects of the student level variables behave in the same way as they did in the previous two models. Minority students have mathematics achievement scores that are 3.10 points lower than white students (γ_{10}, t=11.63). Women also achieve a rate that is lower than men (γ_{20} = 1.07, t=5.53). As in

the other two models, as socioeconomic status increases, a students' mathematics achievement increases by 1.9 (γ_{30},t=15.87).

As we saw in Model Two, Catholic schools have higher mean mathematics achievement than public schools. This continues to be true in Model Three. However, we see that the Catholic school effect is even stronger. In this model, Catholic schools have mean mathematics achievement that is 2.93 higher than public schools compared to 1.25 points in Model Two (γ_{01}, t=14.36). In Model One, we saw that when schools had over 40% minority students in their population, their mean mathematics achievement decreased by 2.35 points. In Model Three we find the same effect, except in this model, mathematics achievement decreases by 2.83 points (γ_{02}, t=-12.44). In this model, HIMINTY and SECTOR have stronger direct effects than they did in the previous models.

In this model, Catholic schools continue to have an egalitarian effect, although the cross level effects are not as strong here as they were in Model Two for the MINORITY-mathematics achievement slope (γ_{11}=2.14, t=4.14) and the SES-mathematics slope (γ_{31}=-.95, t=-3.96). The FEMALE-mathematics slope is slightly stronger than it was in the previous model, but continues to be statistically insignificant (γ_{21}= .46, t=1.12).

The HIMINTY variable behaves the same way in the cross-level interactions in this model, as it did in Model One. Once again, neither the MINORITY-mathematics or FEMALE-mathematics coefficients are statistically significant. The only cross-level interaction that is statistically significant is the SES-mathematics slope. In schools with

over 40% minority students, the SES-mathematics slope decreases by -.89, meaning that SES is translated into mathematics achievement at a rate that is .89 lower than in schools with under 40% students (γ_{32}, t=-3.35). As speculated before, this could be due to the fact that many schools with high minority populations also tend to have students with low socioeconomic status.

Testing the Hypotheses

Now that I have examined each of the models, it is appropriate to take another look at the hypotheses proposed in the previous chapter.

1. Students' socioeconomic status is positively associated with mathematics achievement, when the other independent variables are held constant. Across all three models, we saw that socioeconomic status has a direct and positive relationship with mathematics achievement. In each of the models, as student socioeconomic status increases, mathematics achievement increases by about 2 points.
2. Compared to majority students, minority students should not perform as well in mathematics, controlling for the other independent variables. This hypothesis was also supported in my analysis. In each of the three models, when a student identified as being either African American or Latino, his/her mathematics achievement score was approximately 3 points lower compared to white students.
3. Students who are female will have lower mathematics achievement than those who are male when holding the other independent variables constant. In each of the three models, I found that female students achieve lower mathematics scores than

male students. Female students achieved at a rate that was about 1 point lower than male students.

4. Schools with a higher proportion of students in the academic track will have higher mathematics achievement than schools with a lower proportion of students in the academic track, holding other independent variables constant. In Model One, it is clear that as the proportion of students in the academic track increase, the mean mathematics achievement also increase, compared to schools with a lower proportion of students in the academic track.

5. Schools with over 40% minority students will have lower mathematics achievement than schools with less than 40% minority students, holding the other independent variables constant. In both models using the HIMINTY variable, I found that schools with over 40% minority students in their schools had mean mathematics achievement that was about 2.5 points lower than schools with under 40% minority students.

6. Catholic schools will have higher mathematics achievement scores than non-Catholic schools, when controlling for all the other independent variables. In models two and three we saw that Catholic schools had mean mathematics achievement scores that were 1.25 and 2.93 points higher than public schools, respectively.

7. Schools with a high mean-SES will have higher mathematics achievement than schools with a low mean-SES, when controlling for the other independent variables. The results in Model Two show that as mean-SES increases, mean mathematics

achievement scores increase by 1.01 points compared to schools with low mean-SES.

8. The advantageous effect (slope) of socioeconomic status on mathematics achievement will be less in Catholic schools than in non-Catholic schools, controlling for the other independent variables. Catholic schools were shown to indeed have egalitarian environments. In Catholic schools, socioeconomic status was converted into mathematics achievement at a rate that was lower than in public schools. In other words, in public schools, SES would have more of an advantageous effect in regards to mathematics achievement, than in Catholic schools.

9. The disadvantageous effect (slope) of minority status on mathematics achievement will be less in Catholic schools than in non-Catholic schools, when controlling for the other independent variables. Minority students find a more equitable environment in Catholic schools than in public schools. Their mathematics achievement scores were approximately 2 points higher in Catholic schools than in public schools.

10. The disadvantageous effect (slope) of being female on mathematics achievement will be less in schools with a high proportion of students in the academic track than in schools with a low proportion of students in the academic track, when controlling for the other independent variables. There was a slight increase in the female-mathematics slope in schools with a high proportion of students in the academic track; however, this finding was not statistically significant. It was found that the

socioeconomic-mathematics slope decreased in schools with a high proportion of students in the academic track, meaning that socioeconomic status did not translate into higher mathematics achievement scores. I found that the minority-mathematics achievement slope increases in schools with higher proportions of students in the academic track. In other words, minority students fared better in these schools than schools with a lower proportion of students in the academic track.

Another important finding, though not necessarily one that was originally hypothesized, has to do with females. Though it was found that female students had lower mathematics achievement than male students, none of the level two variables were statistically significant in explaining this variation. It may be that some other factor is at work not measured in this thesis that could explain why it is that women achieve lower mathematics achievement than men. As discovered in chapter two, reasons for the disparity can range from socialization to test anxiety to family support.

In this chapter, I have analyzed the results of three hierarchical linear models. I have partitioned the variance in mathematics achievement that exists at the individual and school levels. Finally, I have tested the hypotheses that were proposed in the previous chapter. Many of the hypotheses were supported by the data, though it is clear that there are some limitations. In the next chapter, I will evaluate the implications of these results and the limitations of this study, and I will present some considerations for future research.

CHAPTER V

CONCLUSION

> The child crisis converges with the failure of the American public school system to accomplish a central part o the mission of schools in a democracy: to rescue children from the limitations of class and family situation, giving them access to a world of longer memory, broader imagination and stronger ambition. The professional and business class avoids this failure either by living in upscale neighborhoods, with better than average public schools, or by sending their children to private schools. The majority of public schools become both a source and a mirror of social apartheid in America. –West and Unger 1998

This research has looked at a number of independent variables and how they influence mathematics achievement. As we saw in the previous chapter, many of the hypotheses proposed were supported. There are some findings that are important to highlight as I conclude this thesis. It will also be necessary to discuss the limitations of this research and present some considerations for future research.

As we saw in the last chapter, the direct effects of the student level variables behaved in the same way in each of the three models. Minorities underachieved compared to white students. Women underachieved compared to men. Poor students underachieved compared to wealthier students. These findings are consistent with previous literature. Students are discriminated against in schools because of personal traits that they cannot change. These effects do not have to do with what these students are capable of achieving biologically. It is not something innate that prevents them from reaching the level that other students are able to. It has to do with how these students are treated and what is decided about them when they go to school. "The system has the

surface aspects of a meritocracy, but merit in this case is predetermined by conditions that are closely tied to race and class. While some defend it as, in theory, 'survival of the fittest,' it is more accurate to call it the survival of the children of the fittest-or of the most favored" (Kozol 1991, p. 60).

As we have seen already, tracking begins at an early age for American students. How they achieve in their initial years of schooling can affect their curriculum placement for the duration of their time in school. Track placement has a big effect on whether or not students go on to college. Student level effects are very important. When looking at these effects, we can see how a reproductionist theory of educational outcomes could be at play. Students who are valued by the society achieve, and those who are not valued are not so fortunate. They may be on paths that reproduce societal norms, fulfilling the roles that are expected of them. Rich, white kids are likely on a collegiate path, while poor and minority students are likely to be in non-academic tracks. The data show us that this is how the students in this sample are achieving.

At the same time, the structure of the school can affect achievement. The data analysis has shown us that schools that have a high proportion of students in the academic track also have higher mean mathematics achievement. What this means is that when schools have more students tracked towards college preparatory paths, the mean achievement is higher than in schools that do not have as many students in the academic track. As we have seen before, low achieving students tend to do even worse when they are put in the same track as other low achieving students.

"We find that the differentiated structure of schools often throws up barriers to achievement and participation of poor and minority students. Measures of ability work against them, which leads to minimal course offerings at their schools and these students' disproportionate placement in groups identified as 'slow.' Once in these classes, their success seems to be further inhibited by the type of knowledge they are taught and by the quality of the learning experiences they are afforded" (Oakes 1988, p. 119).

What is important about this finding is the degree to which tracking can affect students' potential to achieve, especially those in lower tracks. However, when more students are able to have access to the academic track in a school, then presumably they will also be afforded more course offerings, better curriculum, and quality teaching. This, as we have seen, results in an overall increase in the school's mean mathematics achievement.

Catholic schools have a positive affect on students' mathematics achievement as well, regardless of the disadvantaged backgrounds that students may bring with them to those schools. There is more of an egalitarian and academic environment in Catholic schools. This finding is very important, because students who would normally struggle in public schools find a learning environment in Catholic schools that allows them to achieve more. We have seen from the review of literature, other studies have found that the values and practices of Catholic schools have been advantageous to students who attend them. Poor students and otherwise marginalized students are not tracked away from academics in Catholic schools. Instead, they are expected to achieve to the highest

level possible. This does not necessarily mean that public school students should receive vouchers to private schools. However, it could mean that there are practices in place at Catholic schools that public schools should consider implementing in order to increase their students' achievement.

Schools with higher mean socioeconomic status also had higher mean mathematics achievement. We have seen in previous chapters that often schools that are in upper-class areas have more resources available, a greater curriculum offering, and a higher quality of teaching staff. Schools with lower mean socioeconomic status often have to focus their attention and money in other areas, whether it be maintaining their facilities or buying textbooks.

Finally, we saw in the data analysis that schools with a high percentage of minority students (over 40%) in their schools had lower mean mathematics achievement than schools with less than forty percent. There was a slight negative correlation between the MEANSES and HIMINTY variables, meaning that as the percentage of minority students in a school increased, the mean socioeconomic status of the school decreased. As discussed previously, the socioeconomic status of a school matters in the resources available to students. At the same time, schools with a high concentration of minority students experience a new sort of segregation, which often ensures them that they will not have the same opportunities to succeed as their white counterparts.

One very important finding has to do with the female variable. Though it was found that female students achieve lower mathematics than male students, none of the school level variables were statistically significant in predicting a decline in the female-

mathematics slopes. This is significant because it indicates that most likely there are other variables at work that explain why female students achieve at a different rate than male students. The literature has told us that often, female mathematics achievement is influenced by family or peer groups. We often hear that socialization is a key factor in why women do not achieve to the same level as men. It would be important therefore to test other variables to see what is causing this disparity. Are there any contextual variables that do effect female mathematics achievement?

There is some research that indicates that women achieve higher grades in all female environments, so it might be possible that all-female schools could have an impact on female scores. Another contextual variable could have to do with the curriculum of the schools. It seems logical that if women were enrolled at schools that were geared toward math and science careers, their achievement in mathematics would be higher than in other schools. Because it seems that women are socialized out of mathematics courses, it might be useful to have information about parental involvement in the student's education, as well as teaching methods in place. It is difficult to pinpoint what in the context could be causing disparities for women's achievement compared to men.

Limitations

There are other variables that could have beneficial in this study of mathematics achievement. One of those variables includes regional information. It could be beneficial to know where in the country the 160 high schools were nested in, to see if there were further influences of context on mathematics achievement. Each state ranks

differently in terms of academic achievement and the resources allocated to education. Rural areas fare differently than urban areas. Suburban schools are much different than inner-city schools. Knowing where each of these schools is located may tell us even more about the context.

Secondly, there is a decreasing interest in mathematics across the board. It might be important to study teaching methods, classroom practices, and peer and parental influence in order to get a better handle on why children are losing interest in this subject matter. It could be possible that students are not achieving in this subject area, because they simply are not interested in it.

> If we start with 7 million kids who are moving through the educational system, what can we predict if they follow the path that currently exists? By seventh grade, only 11% of the original group of 7 million express an interest in those fields [math, science, and engineering]. That means we've lost 89% of the kids by junior high! By high school, that drops to 8%; by college entrance, 5%. The number who actually get B.S. degrees in math, science, and engineering is only 3%, and only 1% go on to graduate programs in those fields…So that is the nature of the problem we're talking about. And the percentages are far less if we consider only minorities or women (or both!) (Eccles 1997, pp. 69-70).

What we need to consider then is whether students do not achieve in mathematics because they are not interested in it, or if students are not interested because they are not achieving. Regardless, it seems that it would be important to find a way to measure student interest and whether or not interest is shifting to other fields. This could be a difficult variable to measure quantitatively and may need to be explored in further depth using qualitative approaches.

Another area to be considered is mathematics achievement for specific ethnic groups. It is well documented that Asian American students and white students are high

achievers. The data set used for this research grouped Latino students and African American students together. It would be beneficial to consider these groups separately to ascertain how each group is achieving. It is likely that there is a difference between these two groups, which could have to do with language, involuntary versus voluntary immigrant status, as well as how each are treated in schools, and parental influence. Each of these groups of students has different needs in regards to mathematics achievement, which may mean that varied practices would need to be considered in order to benefit these groups of students.

If we had mathematics achievement data about Asian American, African American, Latino, and white students, what could we expect in regards to their mathematics slopes be affected by the contextual variables discussed in this thesis? In schools with high proportions of students in the academic track, I would predict that Latino and African American achievement slopes would be positive, or in other words, these normally disadvantaged students would achieve higher scores than in schools with a low proportion in the academic track. For white and Asian students in the same schools, I would predict that their slopes would also increase, because it seems that schools that adopt this practice benefit all students. However, the advantage that whites and Asians have would be less in these schools than in schools with a low proportion of students in the academic track. In the latter type of school, it is likely that white and Asian mathematics achievement slopes would be higher than that of other minority students.

As we have seen in this thesis, Catholic schools have an equalizing effect for students, so that students who would normally be disadvantaged in public schools are less disadvantaged in Catholic schools. If we had data available on African American and Latino students, I would predict that we would see a similar effect. In other words, mathematics achievement slopes would be higher for these two groups of students in Catholic schools than they would be in public schools. At the same time, we would expect white and Asian advantage to be less in Catholic schools. For each of the individual ethnic groups, we would expect their mathematics achievement slopes to increase as MEANSES increases.

For schools with a high percentage of minority students enrolled, it is difficult to predict how scores may pay out. Because of the relationship between segregated schools and concentrations of poverty, we would expect for students in high minority schools to have lower mathematics achievement slopes compared to mostly white schools. Because of the lack of resources that high minority schools often have, it is difficult to predict how Asian and white students would achieve in these environments. It would also be beneficial to examine further why it is that Asian students and white students achieve at higher levels than other ethnic groups. How does the experience of Asian and white students compare to that of African American and Latino students in any of these contexts?

Implications

Why is this research important? Knowing why students achieve at different levels is significant for many different reasons. First of all, the population of the United

States is changing and will continue to change in the future. Demographers have predicted that minority populations will, over time, outgrow the majority, white population. As we have already discussed, the number of minority students interested in and achieving in mathematic has not significantly increased. "With changing demographics in the next 20 years…it is very clear that we will not be able to meet our resource needs if we continue to rely primarily on the White, male population, our source in the past for scientists. In fact, the situation is serious enough that unless more young women and minorities choose to concentrate in the natural sciences, jobs calling for specialized preparation may go unfilled" (Eccles 1997, p. 67). Clearly, the labor force could be affected by inequities in mathematics achievement as the population changes and our educational system does not.

Specifically for Texas, as the minority student population increases, schools will have to adjust their curriculum and focus in order to ensure that all students will succeed. "In mathematics, Asians perform better than Anglos, who in turn far outdistance Latinos and African-Americans. As the proportion of minority students increases, overall achievement levels will drop even further unless the scores of both Latinos and African-Americans rise" (Bouvier and Poston 1993, p. 56). What this means for schools in Texas is that there will be a great need to reexamine how students of color are taught. Texas already ranks low compared to the other states in terms of educational performance, making it even more important that efforts are made to increase achievement across the board for students.

"The future work force mirrors the changing student body; over the next 20 years, almost all of the net additions to the work force will be women, members of minority groups, or immigrants-many of them persons who, at the present, are being ill-prepared by the schools" (Bouvier and Poston 1993, p. 57). Certainly an inadequately educated labor force will have an effect on the economy, and it will also impact the standing of the United States compared to other countries internationally. Students in schools today are the leaders of tomorrow. The way students are prioritized in the current school system ensures that whites, and likely white men, will most certainly fill leadership positions. This is how inequality becomes structured into American society.

Not only does this inequality affect our society on a practical level in terms of changes in the work force, it also affects our society in a broader way in regards to how education is lived by students of color. Fundamentally, our country is based on freedom and a belief that we have the right to certain things. This has been a misnomer for many students in the educational system, who find that they are not valued in schools because they are not white. If we as a society are truly concerned about making education an institution that all students can benefit from equally, it will be necessary for there to be some major changes in how multiculturalism is viewed.

> Multiculturalism compels educators to recognize the narrow boundaries that have shaped the way knowledge is shared in the classroom. It forces us all to recognize our complicity in accepting and perpetuating biases of any kind. Students are eager to break through barriers to knowing. They are willing to surrender to the wonder of re-learning and learning ways of knowing that go against the grain. When we, as educators, allow our pedagogy to be radically changed by our recognition of a multicultural world, we can give students the education they desire and deserve (hooks 1994, p. 44).

What hooks is telling us is that students want to learn. They want to benefit from their education. They want it to be meaningful. Many times, biases are communicated without knowledge that it is happening; other times they are more blatant. However, in order to ensure that students are all achieving, it is important to consider what they need, and to not assume that old practices will work for all students. Does this mean that schools should be forced to achieve a certain level on standardized tests lest they be subject to closing, as "No Child Left Behind" would have us believe? Not necessarily. Rather, it means looking critically at the education process and honestly assessing whether students are achieving at the levels that they are capable of. This will mean considering how context affects the student, and attempting to change the context rather than run from it.

At the same time, it is important to make sure that people are engaged in making change in the educational process, and that those who are marginalized by the current system feel that they have an opportunity to be heard. This means that people need to be given information about the current situation, how their students compare to others, how their schools compare to others, and finally, a chance to act. "If true commitment to the people, involving the transformation of the reality by which they are oppressed, requires a theory of transforming action, this theory cannot fail to assign the people a fundamental role in the transformation process. The leaders cannot treat the oppressed as mere activists to be denied the opportunity of reflection and allowed merely the illusion of acting, whereas in fact they would continue to be manipulated-and in this case by the presumed foes of manipulation" (Freire 1993, p. 107).

As discussed in chapter one, our governmental policy is focused on the "No Child Left Behind Act" in regards to educational reform. Critics of this policy would agree with Freire, in that parents are not given real options in helping their children achieve. They are given information based on one measurement of achievement, they are not necessarily given information on how the context shapes their students' achievement, they may not have the resources to help their students achieve the way that parents in high achieving school districts can, and they are given the illusion of being able to make change with vouchers and bussing. Furthermore, as reproduction theory suggests, it could be how our society is organized and the emphasis on obtaining wealth that causes these problems in our school system. "Efforts to equalize education through changes in governmental policy will at best scratch the surface of inequality…As long as jobs are defined so that some have power over many and others have power over nothing-as long as the social division of labor persists-educational inequality will be built into the U.S. society" (Bowles 1971, p. 150).

In the case of the "No Child Left Behind" policy, the real issue of inequality is not being addressed, because it is structural in nature. It is difficult to change the context of an inner-city school without also changing the context of society. It is difficult to change the racial composition of a school without also changing residential segregation that occurs in many cities in this country. Change does not come easily when inequality is structured into our institutions. The "No Child Left Behind Act" does not address the matter of discrimination on a structural level. Instead, it serves as a temporary solution,

which may increase standardized test scores, but will ultimately not change inequality on a societal level.

> To succeed in improving the schooling of the dispossessed, educators are increasingly realizing that they need to share power over educational decision-making with representatives of urban communities they serve, that they need to find ways to teach that match the learning styles of the many ethnic groups, that they need to develop many alternatives within the system and to correct the many dysfunctions of the vast bureaucracies created by the administrative progressives…To create urban schools which really teach students, which reflect the pluralism of the society, which serve the quest for social justice-this is a task which will take persistent imagination, wisdom, and will (Tyack 1974, p. 291).

As Tyack suggests, it is important to consider many ideas and solutions when it comes to school reform. In order to truly teach students, there is a need to understand their cultural differences, their varying learning styles, and to give those affected by discrepancies a voice in making change. This thesis has shown that is essential to examine many variables on two levels in order to understand achievement. It suggests that some practices are working for disadvantaged students (especially the practices in Catholic schools and schools with high proportions of students in the academic track.) It challenges the fundamental logic of "No Child Left Behind" by contending that it is not possible for students to achieve equally in the current school system. Without considering the contextual and individual affects on achievement, we will continue to use a formula for low achievement to address these matters.

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