TEACHERS' ADJUSTMENT OF TEACHING PRACTICE IN TRACKED MATHEMATICS

by

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(Under the Direction of Denise Mewborn)

ABSTRACT

This study used qualitative methods to study the teaching of high school mathematics teachers teaching in tracked schools. A comparison between two tracked classes was done for each of three participants. The research questions were the following: (1) What knowledge of students do teachers use to inform their teaching practice? (2) How does this knowledge of students influence their teaching practice? (3) What role does the race or culture of the students have in this knowledge of the students? The findings suggested that in between-participant comparisons, teachers made similar associations between behavior and motivation with the track of the students. Differences in pedagogical approaches in the two classes were directly related to these associations.

INDEX WORDS: mathematics teaching, tracking, teaching expectations

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DEDICATION

This dissertation is dedicated to My grandfather, J.P. Radoff, an original mathematics teacher educator.

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TABLE OF CONTENTS

LIST OF TABLES

Chapter 1
Introduction

The work of teaching is always evolving. Over the past 50 years, we have seen a major change in what it means to do mathematics in school and accordingly what it means to teach mathematics in school. We have moved away from teacher-centered classroom lessons where the teacher illustrates to students how to tackle computational mathematical exercises, and we have moved toward understanding that the level of mathematical proficiency (National Research Council, 2001) expected of students requires a different role for the teacher.

> Curriculum development during the 1960s and the 1970s viewed the teacher's role as that of implementing an expert made curriculum. Teacher-proof curricula, the extreme outcomes of this process, assumed that children could learn directly from ready-made curriculum materials while the teacher, instead of teaching, would adopt a role of manager and facilitator….The mid 1980s marked a change in conceptions of the teacher's role in promoting learning; which now came to include setting mathematical goals and creating classroom environments to pursue them; helping students understand the subject matter by representing it in appropriate ways; asking questions, suggesting activities and conducting discussions. (Even & Tirosh, 1995, p.2)

The new role for mathematics instructors challenged the sufficiency of merely being able to "do" mathematics and then to explain it well to others. Mathematics teachers needed a deeper understanding of mathematics in all of its complexities in order to create learning environments for students that went beyond teaching them to do mathematics in procedural and rote ways but instead would promote this mathematical proficiency.

Mathematics teaching is undergoing further redefinement as ancillary requirements are added. Not only must mathematics teachers ensure that students become mathematically proficient, but in the past decade policy has mandated the mathematical achievement of *all* students, especially students who have been historically underrepresented in mathematics and science careers.

> In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed. (NCTM, 2000, p.5)

This new task of ensuring that every student be given opportunities for high quality mathematical learning implies a new role for the teacher who must ensure that all students are engaged in meaningful mathematics, while still being mindful of the individual needs of students. This is complex task given the increasing diversity of students in terms of backgrounds, culture and language in our public schools.

This dissertation began as a study on teacher knowledge. I wanted to understand how teachers used knowledge about their students to adjust their teaching practice in an effort to effectively teach all of their students. To do so, I designed a study in which I would observe the teaching of my participants in two different classes. To make a comparison, I decided to pick two of each participant's mathematics classes, each on a different track. As I collected my data and began the analysis, the study became more and more about tracking and how the students in those classes were taught differently. My original goal of understanding how teachers taught students differently became connected to how they taught different tracked students differently and how their knowledge about those tracks informed their pedagogical choices.

Keeping with the idea that advanced mathematics should not be reserved for the brightest students only, the three schools in which I was collecting data had made a concerted effort over the previous several years to offer the majority of their students the opportunity to take academic as opposed to vocational courses. One high school, which for years had grouped students into either technical preparatory classes or college preparatory classes, had created advanced college preparatory classes so that more of the average students might take the college preparatory classes. The truly advanced would take the advanced college preparatory classes, and the rest would take technical preparatory or if they qualified special education courses. However, although the college preparatory classes at this high school were more inclusive, the ills associated with tracking were still present. At this school, racial parity was not present. The advanced college preparatory classes had many White and Asian students, whereas most Black students were in the regular college preparatory classes or the few technical preparatory classes. Even though the school made some attempt to make tracking more equitable by allowing more students access to the college preparatory classes, access to the same learning experiences was undermined by what seemed to be an upward translation of original tracking practices. In other words, the schools just added on one more track and shifted the majority of the students up into a higher, but not the highest track.

Tracking or ability grouping has been an issue for decades. The argument for and against placing students into homogenous ability groups remain the same. The pros are that tracking allows students to work on their level without retarding the higher students and not frustrating the lower students. It also makes the job easier for the teacher who in a homogenous class setting is more able to adapt his or her teaching style to accommodate the particular groups of students. Finally, it preserves the self-esteem of the lower-level students, who would be susceptible to feelings of inadequacy when placed with more advanced students. Those against tracking argue that homogenous grouping of students takes away opportunities for lower-level students to learn from higher-level students; creates a stigma associated with placement in lower-level classes; and creates more work for the teacher who must adapt teaching practices to address different groups of students. Issues of over-representation of minorities and poor students in the lower-level classes and the ways in which tracking perpetuates social stratification are also cited as reasons for which tracking is not inline with notions of democracy and equity (Slavin, 1990).

Adding further confusion to are the results of studies that have been inconclusive about the effects of tracking on student achievement. Studies comparing students in homogenous classrooms to those in heterogeneous classrooms have indicated no statistically significant difference in achievement for either. That is, there is no real benefit in mixed-ability grouping or homogenous ability grouping based on the results of these studies (Slavin, 1990). On the other hand, studies investigating differences in academic gains between tracked students have concluded that higher-tracked students achieved greater gains than lower-tracked students (Gamoran, 1987).

With the effect of tracking on achievement difficult to discern, given the complexity of isolating the impact of tracking from other potentially influential factors such as course taking, student motivation, and initial differences, ethnographic studies have looked at differences in learning opportunities and instructional practices in tracked classrooms (Oakes, 1985; Boaler, William & Brown, 2000). These studies suggested that there were differences with respect to classroom instruction, knowledge learned, and tasks posed with the lower-level students often losing out. Research on tracking done extensively in both the United States and the United Kingdom has been by and large quantitative with an emphasis on studying whether there is an effect of tracking on achievement. Far less common is research that takes an in-depth look at how tracking promotes differences in learning experiences for different groups of students (Boaler et al., 2000).

Regardless of the results of such studies and the moral debates on the topic, secondary schools in this country still use tracking as an organizational tool. It is difficult to determine the exact percentage of secondary schools in the United States who use homogenous ability grouping of students, because the word *tracking* has taken on such a taboo connotation that schools shy away from describing their organizational practices in that way. The following is from the National Center for Educational Statistics (NCES) website and illustrates the difficulty in pinpointing the actual percentage of secondary schools that track. Based on a survey conducted on a national representative sample of 912 secondary schools:

> Most public secondary schools (86 percent) reported offering courses in their core curriculum that are differentiated in terms of content, quantity or intensity of work, or expectations regarding independent work. However, only 15 percent of schools described themselves as having traditional "tracking" policies, reporting that they offer differentiated courses and do differentiated grouping in their core curriculum. The majority of schools (71 percent) indicated that they offer differentiated courses, but give students open access to any course provided they have taken the prerequisite course(s). (NCES, n.d.)

As indicated, many schools suggest that they do not have strict tracking policies in that they let students take courses of their choosing. However, the extent to which students really have much influence is questionable, especially given that many schools use a combination of prerequisite courses, prior achievement, and teacher recommendation alongside student requests to decide who goes where. Regardless of the process for determining placement, the above statistics indicate that the vast majority of the secondary schools in the United States use tracking as an organizational tool. The debate about tracking is still relevant to any discussion about secondary education.

Although tracking continues to be the way in which the majority of secondary schools organize their classes and students, there have been changes in the process of grouping students. For one, those classes considered college preparatory have become more inclusive; the high school described in the beginning of the chapter typifies a trend. In many schools, the majority of students take college preparatory classes (Gamoran & Berends, 1987). NCES reported that for each racial group, more than 80% of secondary students took either advanced academic classes or middle academic mathematics classes (Hoffman, 2003). However, as Gamoran and Berends suggested, even though schools have the majority of students in academic classes, these schools "may be highly stratified" (p. 421). Therefore, the historical comparison of vocational preparatory to college preparatory classes is no longer the only worthwhile comparison. The majority of students, at least with respect to mathematics, are taking academic classes, so the more worthwhile comparison is between those classes considered the advanced with average or middle-level classes. Further, older studies of tracking including the one most cited one to date Oakes (1985), a comparison between low-track and high-track mathematics classrooms, described astounding differences in the content learned. The low-level students were doing consumer mathematics and focusing on basic skills while the higher-track students were doing mathematics necessary for continuation to college. Today, the push for algebra for all students has even the lowest diploma at a high school requiring mathematics through algebra I. That is, even low-level mathematics students will be expected to master algebra, a subject once thought only appropriate for college bound students.

In the early 1980s, when Oakes (1985) reported on the state of tracking in secondary schools, she described the classrooms that she saw as passive and nonengaging for students:

> The most significant thing we found is that generally our entire sample of classes turned out to be pretty noninvolving places. As we expected, passive activities—listening to the teachers, writing answers to questions, and taking tests—were dominant in all track levels. And, also not unexpected, the opportunities students had in any group of classes to answer open-ended questions, to work in cooperative learning groups, to direct the classroom activity, or to make decisions about what happened in class were extremely limited. (p.129)

In particular, she found that in mathematics, students at all levels were involved in similar activities.

> At all levels, a great deal of memorizing was expected, as was a basic comprehension of facts, concepts, and procedures. Students at all levels were also expected to apply their learning to new situations—whether it was the application of division facts to the calculation of automobile miles per gallon of gasoline in low-track classes or the application of deductive logic learned in geometry to the proof of theorems and corollaries in calculus. (p. 78)

Given the emphasis in mathematics education to move teachers away from a teacher-centered, lecture-style approach to teaching to a more exploratory, student-centered approach, I would hope that this passivity that Oakes described in classrooms as well as the limited mathematics students were expected to learn might have changed somewhat. There are certainly many mathematics classrooms that still resemble those described by Oakes in the early eighties. However, with the mathematics education community's push for more engaging mathematical learning experiences for students as well as greater conceptual understanding (NCTM, 2000; National Research Council, 2001), we might expect that there has been some shift in mathematics teaching towards this vision. It is important to consider tracking in mathematics and differentiated learning experiences for tracked students in a context where good mathematics instruction has been redefined.

My study offered a chance to look at the differences in instruction and learning opportunities in tracked classrooms in the context of present-day mathematics classrooms. In addition, because lower-level mathematics has taken on a new meaning given the expectation that all students will graduate having taking Algebra I, I expected the comparison of lower-level classes to higher-level classes to be qualitatively different than that described in earlier studies on tracking (e.g., Oakes, 1985) as the content would now be college preparatory for most. My study offered an important comparison of not just lower-level mathematics classes to higher-level mathematics classes, but also to the ever-growing middle academic classes, which have not been given much emphasis in the literature on tracking. Finally, my study attempted to move beyond just pointing out differences between classroom experiences but also described the instructional choices that teachers made with respect to different groups of students. I studied such differences along with my participant views on their students and the connection between their knowledge of their students and their instructional practice to provide a holistic analysis of the differences in mathematical experiences for students in tracked classrooms.

Purpose of the Study

The purpose of this study was to understand how teachers accommodate their instruction for students in tracked mathematics classrooms as well as to understand how those accommodations are related to how the teachers define their students. My study investigated the ways in which the teachers used their knowledge of their students to inform their approach to teaching mathematics.

My research questions were as follows:

1. What knowledge of students do teachers use to inform their teaching practice?
2. How does this knowledge of students influence their teaching practice?
3. What role does the race or culture of the students have in this knowledge of students?

In the following chapter I provide the literature that provided a framework for the design of my study as well as my data analysis.

Chapter 2
Literature Review

Two main bodies of literature influenced my study: the research on tracking and the research on teaching as decision making. As tracking started to emerge has a major contributor to what I was seeing in my study, it was necessary to locate the key research as it related to my research questions. In particular, I included research on differentiation in learning experiences and instruction in tracked classrooms. Also, as my study dealt specifically with teachers' knowledge of their students, I included research on teachers' beliefs associated with tracking. The second body of literature provided a rationale for regarding teaching as an informed decision-making process. This research provided an important construct describing the complexity of teaching when different influences are present. Finally, I included literature that on culturally relevant pedagogy. This is literature is secondary because while it informed my design of the study, it was not as helpful in analyzing the data. This literature helped me to form a hypothesis for what I hoped to see in my data, but did not actually see. It helped me to describe what I was not seeing.

Research on Tracked Classrooms

The literature that sets the context for this study includes studies that investigated differentiated learning experiences and instructional practices in tracked classrooms, as well as teacher beliefs about tracking and tracked students. A common finding—one that helps fuel the fight against tracking—is that teachers in an ability-grouped school are more likely to expect students in higher-tracked classes to be more responsible and more capable of analytic thinking than lower-tracked students (Hallman & Ireson, 2005), which leads to very different classroom experiences for students, depending on their appointed track. Goals for teaching are differentiated. Teachers of higher-track students want their students to be independent thinkers, whereas those of lower-track students focus on ensuring that their students gain low-level skills and discipline (Oakes, 1992). Classroom experiences for students are thus differentiated depending on the track, with the majority of the teachers surveyed by Hallman and Ireson reporting that in lower-level classes greater opportunities for structured repetitious practice were offered compared with more discussion offered for higher-level students. These same teachers reported offering fewer or shorter homework assignments for the lower-level students than for the higher-level students.

Another finding was that teachers of tracked students saw them as a homogenous group of students so that differentiation in instruction within a tracked class was not necessary. In higher-level classrooms, teachers relished the opportunity to push all students because they were thought to be able to work harder and faster given their advanced status regardless of their success in the class. In this way, the track a student was in defined his or her ability for the teacher. Hallman and Ireson’s (2005) study comparing teachers’ perceptions of students in mixed-ability versus tracked classes found that there was a difference in their expectations of higher-level students if they were referring to a tracked class. Teachers expected to be able to cover more material and delve further into concepts if the students were tracked as opposed to being in a mixed-ability classroom. This result led Hallman and Ireson to conclude the following:

> What these differences signify is the power of grouping structures to influence teachers' expectations and teaching practices. The same teachers responded differently to questions about their practices depending on the type of class to which they were referring, mixed or ability grouped. (p. 20)

Boaler et al. (2000) drew similar conclusions based on their interviews with tracked students and observations of tracked mathematics classrooms in several British secondary schools. Based on the student reports of the pressures and expectations they felt from their teachers as well as the instructional practices observed, Boaler et al. (2000) concluded:

> When students were divided into ability groups, students in high sets came to be regarded as “mini-mathematicians” who could work through high-level work at a sustained fast pace, whereas students in low sets came to be regarded as failures who could cope only with low-level work—or worse—copying off the board. This suggests that students are *constructed* as successes or failures by the set in which they are placed….” (p. 643)

Boaler et al. found that teachers in tracked schools saw homogenous grouping as an opportunity to teach mathematics in each class without having to worry about differentiated instruction.

The students in the tracked classrooms observed by Boaler et al. (2000) complained of the pace being too fast if they were in the high-track classes and the work too basic if they were in the low-track classroom. Teacher responses to the students' complaints suggested that they believed the work and pace of the class were appropriate given the students' placement in the track and therefore no accommodation was made. Boaler et al. and Hallmand and Iresom (2005) point to the influence of the system of tracking itself and students' labels on teachers' pedagogical choices for their classrooms. In both studies, the teachers' instructional practices were tied to their beliefs about the students in the class based on their position in the tracking hierarchy.

Differentiation between classroom experiences for students in tracked schools has been studied. In one of the most well-known studies on tracking, Oakes (1985) used data collected during the 1970s from about 25 secondary schools to describe the differences between lower-track and higher-track English and mathematics classrooms. These differences were characterized in terms of the content students were exposed to; lessons learned by students outside of content; opportunities in the classroom for learning to take place; and differences in the learning environment in the classroom. Using survey data collected from teachers and students, artifacts including actual curricular materials, and interviews with teachers in different tracked classes, Oakes found major differences with respect to these categories between tracks. Oakes used three categories of classes in her comparison—lower-track, average-track and higher-track classes.

Differences with respect to content. Oakes (1985) reported that higher-track students in mathematics and English were more likely to learn content that would be required at universities. They spent much of their time developing scholarly skills such as analyzing literature texts and conducting research projects. In addition, Oakes found that class time was allotted for college entrance activities such as preparing for the Scholastic Aptitude Test (SAT) in the higher-track classrooms. The story differed for lower-track students who were more likely to spend time learning basic skills such as doing computations or applying basic skills. Oakes reported that the students in the lower-track classes were not exposed to sophisticated mathematical ideas but rather practical mathematics concepts such as those presented in a *consumer mathematics* class. The average-track classes, those that were not remedial but not Advanced Placement (AP) or honors classes, were described as “diluted version[s] of that of the high classes” (p. 77). Oakes found that these average-track classes were more like the higher-track classes than the lower ones. This was especially true for mathematics courses taken after tenth grade because past that level the mathematics courses, no longer required courses, were considered advanced.

Lessons learned outside of content. From her data, Oakes reported that the majority of teachers surveyed described teaching lessons to their students that transcended content. These included lessons about life, productive citizenship, and student behavior. The teachers were asked to respond to a question about the five crucial lessons that they wanted students to learn. Oakes organized responses into two categories: *independence* and *conformity*. The high school mathematics and English teachers in the lower-track classes reported wanting their students to develop behavior that would allow them to be productive members of the classroom—including developing listening skills, getting along with peers, and following rules. The higher-track mathematics and English teachers reported desires for their students to be critical and independent thinkers as well as self-directed in their approach to learning. These different goals for student learning materialized as indicated by the responses of students to Oakes’ questions of the most important things they learned in school. Students’ responses matched the goals of the teachers. Students in the lower–track classes named lessons on how to behave in a classroom as the most important thing learned during that year. The higher-track students reported learning how to think logically, to communicate their thinking effectively, and to solve problems.

Opportunities in the classroom for learning. Using teacher self-reports and observation data from classrooms, Oakes (1985) reported that there was a discrepancy between the amounts of time allocated for learning. Discrepancies in the percentage of time devoted to instruction, assigned homework, and observations of classrooms indicated that lower-track students were provided less time to engage in learning activities. Lower-track students were observed being off task more often than higher-track students. Likewise, students in lower-track courses reported that their teachers spent more time on discipline. All of the above accounted for differences in the amount of time dedicated to content instruction in the classrooms. Teacher effectiveness, also taken as an indication of the opportunities provided for students to learn, varied depending on the level of the class. Teacher effectiveness was measured by several factors including lucidity of explanations about lessons, use of varied instructional resources, organization of lessons, an enthusiastic approach to teaching the subject, refraining from criticizing students, and matching the content taught to the objectives for the lesson. In surveys, higher-tracked students reported their teachers as more effective than lower-tracked students.

Differences in classroom climate. The concept of *classroom climate* is defined by Oakes (1985) to include the relationship between the teacher and the students, peer relationships, student engagement with the material to be learned, and the role that the students played in the learning environment. The data used to assess classroom climate were based on teacher and student surveys and observation data. The results indicated a difference in classroom climate between the lower- and higher-tracks. Teacher-student relationships were focused less on discipline in the higher-track classrooms than in lower-track classrooms. Teachers reported that peer relations in the higher-tracked classes were congenial versus explosive as in the lower-track classes. Teachers and students in the higher-track classes reported that the students got along well and helped each other whereas there was yelling and fighting in lower-track classes. Student roles in the two tracks were not much different, with neither low-track nor high-track students playing an active role in the activity of the classroom. Oakes suggested that student passivity was characteristic of education during the late 1970s. However, she did suggest that those few activities that required student activity such as field trips were done with the higher-track classes.

The review of research on tracked classrooms indicate that students may be held to different expectations and have very different learning experiences depending on the classroom in which they are placed. Teachers have different goals for students depending on what track they are assigned. Further, sometimes these goals are not based on the student as an individual but have more to do with the label placed on them by the tracking system (Boaler et al., 2000). In the next section, I take a deeper look at what the research says about how teachers view tracking and its relevance to instruction. This literature is important because it further suggests how teachers define their students in terms of their placement.

Teachers' Beliefs about Tracking

Oakes (1997), in a study of de-tracking attempts in a secondary school, described two possible approaches to student ability that lay the foundation for why an educator might support tracking versus de-tracking. The difference lies between seeing student ability as innate and fixed versus multi-dimensional and flexible. If student ability is rigid, then it is reasonable to assume that by middle school and certainly by high school, educators should be able to distinguish the bright students from those deserving a place in the lower-track class. Oakes and Guiton (1995), in their study of how students are placed in tracks, found that by holding this belief in the "stability in students' intellectual capacity" (p.11), teachers in the schools they were studying were unable to recall more than a handful of students who were successfully able to switch from a lower track to a higher track during their high school careers. If a student was able to make the move, the transfer was attributed to initial misplacement in the wrong track. The student's ability had not changed, but rather someone had discovered the misplacement. Oakes (1997) found that those teachers who were fighting for de-tracking often adhered to some variation of the belief that ability was flexible and assessed in ways that were not necessarily inclusive of all cultures. For example, Oakes (1997) reported one teacher who described the need to incorporate different learning styles for the diversity in the classroom with the goal that each student would be able to learn successfully versus placing him or her in a lower-level class.

Beyond ideological considerations, a teacher seeing tracking as a working system that both sorts accurately and provides the best structure for ensuring that all students are receiving the best education cannot be blind to the lack of rigor and the lack of flexibility inherent in the process of labeling students for their destined track. Oakes and Guiton (1995) provided a comprehensive description of how tracking works in schools. First, tracking serves as an organizational mechanism. Large numbers of students are organized into a small number of classes with caps on maximum enrollment. In the simple act of trying to place each student in the appropriate class for their given regime, everyday realities can interfere with the school's ability to put the student in the most appropriate class. Oakes and Guiton cited obstacles such as limited resources and available qualified teachers, among others, that create problems in making tracking 100% foolproof. Oakes and Guiton also cited the ways in which decisions are made about student placement as undermining the fixed nature of tracking labels. In the schools that they studied, decisions about placement of students in tracks were based on a combination of student and parent requests, teacher recommendation, past student performance, and test scores. If there was a question about placement of a student in an academic course, the student's preference took a back seat to the requirements: previous performance, teacher recommendation, and test scores. Although the placement regime was seemingly clear cut, Oakes and Guiton discovered that when a parent had a problem with the placement of a student, the school tried its best to follow the desires of the parent for the child's placement. The schools being studied did not advertise this procedure openly, but in general it was the policy that educators and administrators followed. Further adding to the subjectivity of student placements in tracks were issues surrounding teacher beliefs about student abilities because of race, culture, or socioeconomic status. In Oakes and Guiton's study, despite awareness of the prejudice that went along with the making of recommendations, teachers still felt confident that overall the system was a reliable way of sorting students.

The research discussed above suggests that teachers' beliefs about tracking are mediated through ideology about intelligence as being fixed versus fluid as well as the value they placed on the realities of the influence of organizational structure, parents, and racism on the ways in which students are labeled in a tracked school. Other contributions to teachers' support or disapproval of tracking included their own personal experiences or their children's experiences with tracking. In one case, dismay at seeing her own child placed in a lower-level class led a teacher to speak out about how a system of tracking often ignored the multiple intelligences of students (Oakes, 1997). However, Ansalone and Biafora (2004) found that even though less than half of the teachers surveyed felt positive about their own experiences of being tracked in school, almost all still supported tracking. Several of those who recalled their tracking experiences suggested that though tracking might limit opportunities for students in lower levels, their futures are not determined, and they could still rise up and be successful.

Teachers' views on lower-level students. Beyond teachers reporting differences associated with ability—that is, that higher-level students are more capable and more responsible—other differences not necessarily related directly to ability are described in the literature. For example, teachers report having more behavior issues in lower-track classes (Hallman & Ireson, 2005).

The association between low-ability students and poor behavior has been suggested over and over again (Oakes, 2005). This association allows teachers to suggest that there is greater importance in focusing on issues of discipline and respect during classroom time, as opposed to helping lower-level students develop into critical, independent thinkers. Oakes (1997) suggested that lines between bad behavior and low-ability status have blurred, as she asked:

> Are slow students in fact characteristically unmanageable? Does classroom misbehavior constitute a part of low ability or achievement? Or, and this seems more likely, are unmanageable students often labeled slow and placed in low-track classes regardless of their academic aptitude? (p. 90)

Oakes (1997) makes problematic teachers' claims that lower-level students are less disciplined, more likely to explode, and disrespectful, especially when the lower-level students are racial minorities. She explored the relationship between classroom track and behavior in the context of racially and culturally diverse schools. She found that what teachers were describing as poor classroom behavior was really behaviors that were culturally specific.

> Many explanations of intelligence grounded in culture or social deportment inevitably break down along racial lines to the point that African American, Latino, and Native-American students must literally "act white" in order to be perceived as intelligent by many of their teachers. Some educators in schools we studied employ very race-specific understandings of culture as it relates to academic ability. In particular, Native-American children are perceived to be disadvantaged because they are too reserved; African-American children are perceived to disadvantage themselves because they are too forward. But rarely, if ever, is the culturally based standard against which students are measured questioned. (p. 491)

Tracking cannot be taken as an objective, separate societal mechanism. It is necessarily intertwined with issues of race and class. Therefore, when teachers in lower-tracked classrooms suggest that teaching conformity is more crucial than independent thinking, we must keep in mind the issues of race and social class that are at play, especially given the prevailing association of deviance with Black students.

Black students, particularly males, are more likely to receive severe forms of discipline such as suspension from school than their White peers (Hoffman et al., 2003). Although everyone is well aware of the media-induced message that Black males are violent, some scholars have approached the racially-marked problem of discipline with the idea that there is a cultural disconnection between Black students and their White teachers such that the students' behavior is often misconstrued as being disruptive (Townsend, 2000). Further, Skiba and Michael (2002) found that whereas White students were disciplined for major infractions such as "smoking, leaving without permission, obscene language, and vandalism" (p. 334), Black students were punished for infractions that are less concretely deviant, such as for "disrespect, excessive noise, threat, and loitering" (p. 334).

> That is, white students are referred for objective actions (e.g. smoking, vandalism) that leave permanent products. Reasons for black referrals to the office, on the other hand, are infractions (e.g. loitering, excessive noise) that require more subjective judgment on the part of the referring agent. Even the most serious of the reasons for office referrals among black students, *threat*, is dependent on perception of threat by the staff making the referral. (p. 334)

Thus, when teachers are making claims that they must focus on discipline or teach their lower-level students to be productive citizens, one has to wonder to what extent these students are losing out on opportunities to learn higher-level knowledge because of a mismatch between the norms of conduct of the teacher and the students as opposed to lack of ability.

Although the literature reviewed here suggests that teachers are to be blamed for differentiation in goals, expectations, and instruction for tracked students, other research on tracking suggests that teachers are not malicious in their pedagogical decisions.

Teachers in Tracked Classrooms

Teachers, especially those of lower-track classes, are either the least seasoned teachers in the school and therefore are initiated by being given the lower-tracked class (Oakes, 1992), or, in the case of lower-income, high-minority schools, they are often reported as being ill-equipped because they lack the necessary qualifications (see Darling-Hammond, 1996). If not falling into one of those categories, then teachers of lower-track classes are perceived as basing their teaching practice on a system of beliefs founded on a deficit model of lower-tracked students. All of the above paint a portrait of teachers who seem malevolent and unwilling to provide lower-track students with equitable educational opportunities to those received by the students in the higher track. Ansalone and Biafora (2004), based on their study of 124 elementary school teachers, found to the contrary that although many of the teachers did admit to altering their pedagogical practices depending on the ability-level of the class in which they were teaching, they were still “willing to work hard to present the entire curriculum to all students and to assist all students regardless of track” (p. 256). The teachers did not indicate that they felt that the lower track students were not teachable. This result suggests that although teachers may support tracking, they do not see teaching the lower-level classrooms as a wasteland or a place in which they do not have to teach to the same level required of them in higher level classes. In fact, Ansalone and Biafora reported that for the teachers surveyed the general response to questions about adjusting teaching practice suggested that these teachers wanted to provide all students with a similar curriculum. Further, Hallam and Ireson (2005) suggest that the teachers in their study rejected the notion that they spent more time preparing for teaching the higher-level courses than the lower-level courses.

For the purposes of this study, I did not approach my participants as being anything but dedicated hardworking teachers trying to ensure the success of their students. I regarded them as decision makers who mediated many different priorities at one time, including mathematical goals, nonmathematical goals, classroom management, and needs of the students. Studies that have looked at teaching holistically have tried to analyze teaching with regards to the many different facets that make teaching complex. In the next section, I discuss that research.

Research on Teaching Practice – Teaching as Decision Making

Framing my study was the idea that teaching is a complex task such that teachers are in constant negotiation with competing priorities (Skott, 2001). Studying teaching in its context—that is, the classroom—was important to my study as I tried to understand what aspects of their students teachers drew upon when making decisions about pedagogy. In so doing, I pulled from several studies in mathematics education that talk about teaching as the act of decision-making and inextricably tied to the context of the classroom.

Scholars such as Skott (2001, 2004) and Sztajn (2003) have shown how teachers' pedagogical decisions about mathematical reform in their classrooms are often shaped by their attention to nonmathematical factors. Skott (2004) used the concept of "forced autonomy" to describe how mathematics teachers struggle to create the vision of school mathematics that closely resembled the vision for school mathematics described by NCTM (2000). Given the end result of what mathematics teaching and learning should look like, teachers are left with the task of deciding how best to make such a vision materialize in their particular classrooms, a role that Skott likened to imposed autonomy on teachers.

> The concept of forced autonomy implies that the teacher is required to play a substantial role as a link between two sets of specific social spheres. One is the macro-sphere of school mathematics and consists of the priorities of the subject as described in the reform literature, in curricular frameworks, and to some extent in pre- and in-service teacher education programmes. The other is the emerging micro-sphere of the mathematics classroom as framed by the specific institutional context of the school and its immediate social surroundings. Forced autonomy, then, refers to the demands put on the teacher as a result of his or her move to the centre stage of curriculum enactment. (p. 240)

In this role the teacher is often called upon to choose between competing priorities, some mathematical and some not. For example, Lampert (1985) described teachers as “dilemma managers” who weigh the consequences of making particular choices in the act of teaching and struggle with making the best decision. In the results of her self-study of teaching mathematics in an elementary school classroom, Lampert illustrated how mathematical and nonmathematical priorities competed for her attention as she tried to create a gender-equitable mathematics environment for all of her students while maintaining classroom management. Trying to maintain classroom order so that the class could engage in mathematical discussion, Lampert described giving more attention to the more active male students in her class who were more likely than the girls to cause classroom disruption. In so doing, she found that the girls were less engaged in the discussions than the boys. She was stuck between giving more attention to the boys to keep them on task and giving equal attention to the girls so as to ensure their active participation.

> My aims for any one particular student are tangled with my aims for each of the others in the class, and, more importantly, I am responsible for choosing a course of action in circumstances where choice leads to further conflict. The contradictions between the goals I am expected to accomplish thus become continuing inner struggles about how to do my job. (p. 182)

Lampert summed up the complexity of teaching and gave a good example of the type of forced autonomy described by Skott (2004). Here, creating gender-equitable learning environments for students came into conflict with the social context of the actual classroom, creating a conflict in which Lampert had to make a decision that she saw as having potentially detrimental consequences for at least one group of students.

When various priorities compete for attention in the classroom, teachers must make decisions that might result in what appears to be ignoring of their own goals for mathematical teaching and students' learning. To the outsider, for example, observing Lampert's class on the day in which she was focusing much of her instructional attention on her male students, it might appear that the teacher was not interested in issues of gender equity. However, in interviewing her, the observer might find that she was very interested in ensuring that her female students were as involved in classroom activity as the male students. At the time, issues of classroom management might take priority over issues of equity, especially if she thought that creating an orderly classroom environment, one in which all students had the opportunity to speak and others listen attentively, would promote mathematical thinking.

Skott (2001) further illustrated this idea of competing mathematical and nonmathematical priorities in his study with a beginning mathematics teacher. The teacher who Skott described as showing "a strong resemblance between his school mathematical priorities and *the reform*" at times exhibited teaching practice in strict opposition to this style of teaching. *The reform* was taken in this case to mean a move towards more student-centered, discovery-based teaching and away from lecture-style, teacher-centered approaches. In observations of Christopher, the participant in the study, Skott noticed that his teaching style was sometimes less reform and more traditional. Skott offered an explanation for these observed differences between espoused beliefs about mathematical teaching and learning and actual practice that went beyond thinking of them as indications of inconsistency. In the study, Christopher described other nonmathematical priorities he had, such as those dealing with student self-esteem or classroom management. Skott concluded that though the teacher's beliefs about mathematics teaching and learning played an important role in framing his teaching, these were "sometimes regulated or overshadowed by more general education priorities such as building students' confidence or by practical concerns such as managing the classroom" (p. 21). Skott offered a model for making sense of the relationship between the teacher's practice and his mathematical and nonmathematical priorities. When the focus of the teacher was on student mathematical learning, his priorities were consistent with his belief that reform-based teaching created the best learning environment for students. However, when his focus was on building student self-esteem, the priorities for his teaching changed to accommodate the shift in focus, such as guiding the student a bit more so as to ensure that the student was successful in solving the problem. Skott painted the picture of a teacher moving between various roles during any given time in the classroom lesson and with each role different priorities emerged and impacted his practice.

Sztajn (2003) looked at how two teachers' beliefs associated with the socioeconomic background of their students interfered with their efforts to teach mathematics in line with the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). Sztajn observed the two teachers throughout the entire school day. From these observations and discussions with the teachers about their work, she found that the teachers' pedagogical stance was very much attuned to the beliefs they held about more ideological constructs such as the purposes of education and the needs of their particular students. For example, one teacher believed that her lower-income students came from unstructured home lives and it was her duty to teach them discipline and order. Her teaching of mathematics was inline with that goal, as her teaching was categorized as drill and practice. Sztajn suggested that although the teacher saw the importance of critical thinking skills and problem solving, she believed that her students needed to practice and master basic skills. "Most important to Teresa is the fact that learning and following rules in a responsible and organized way is what her students need in order to find their place in society" (p. 64). Sztajn's study is crucial to any discussion on the influences on teachers' decision making in the classroom because it adds another component to competing priorities. As she writes, "My research takes into account the macro-structures of school mathematics and brings ideology into the picture" (p. 55). Sztajn's study points to the need to look beyond the influence of classroom interactions on teachers' pedagogical choices towards larger social ideas that affect teachers as well.

Potari and Jaworski (2002) offered a model for analyzing the complexity of teaching. Their model, *the teaching triad* (TT) had three components: management of learning, sensitivity to students, and mathematical challenge. Based on an earlier ethnographic study of mathematics teaching (Jaworski, 1994), the triad was used in their research to study "the full complexities of teaching and reveal its tensions, issues and dilemmas that teachers face in constructing effective learning situations for students" (p. 354). The components of the triad describe the complexity in teaching that Jaworski (1994) saw in the mathematics teaching that she observed. *Management* *of Learning* (ML) described the teacher's attention to creating a learning environment for students. As Jaworski's study focused on teachers whose teaching adhered to an investigative approach to mathematics learning, management of learning often described the ways in which the teachers organized the classroom and the lesson so that students could learn through discovery. *Sensitivity to students* (SS) described the ways in which teachers were respectful of student thinking, used knowledge of students to inform interaction, offered feedback in a way that contributed to a trustful relationship with students, and in general paid close attention to the needs of students. Finally, *Mathematical Challenges* (MC) pointed to the teacher's effort to probe and push student mathematical thinking so that students were adequately challenged in the learning environment. This challenge could be through questioning, scaffolding, or making suggestions to the students about how they might proceed in a mathematical investigation. Jaworski (1994) offered excerpts from her participants' mathematics teaching that illustrated the ways in which these components were both separate as well as intertwined. She described the relationship between the three this way:

> I see the teaching triad here in terms of the relationship between sensitivity to students and mathematical challenge in enabling students to make progress within an environment which creates opportunity for involvement at an appropriate level for all students. It is the management of learning which enables this environment and supports the balance of SS and MC" (p. 132).

The teaching triad (Jaworski, 1994; Potari & Jaworski, 2002), although mainly focused on the mathematics teaching and learning observed in the classroom, does leave room for a discussion about nonmathematical factors that compete for the teacher's attention while making pedagogical decisions in the classroom. Potari and Jaworski incorporated the possibility of the impact of noncontent specific influences on teaching practice. With the teaching triad, they "were able to go beyond simplistic judgments about lessons to search out cognitive and affective factors in learning and the wider social issues and concerns that impinge on classroom decisions" (p. 352). For example, included in one illustration of the SS component of the triad is a teacher's rationale for what might appear to the observer as his imposing his own approach to solving a problem onto his student. This imposition might appear to go against the teacher's goals of teaching mathematics based on student investigation and self-discovery; however, with more careful understanding of the different influences on a teacher's pedagogical choices, Jaworski saw that this choice of scaffolding was based on his recognition of this particular student's independence. The teacher interpreted his student's independence as stubbornness. He would not adopt the teacher's method unless it made sense to him. That is the teacher did not worry that he would be in any way imposing his own method onto this particular student.

Similarly to Skott's study (2001), the teaching triad offers a more complete analysis into the study of teaching as it suggests that researchers should see teaching holistically, as a decision making process based on several factors, some mathematical and some nonmathematical. Patori (1994), Patori and Jaworski (2002), and Skott (2001) all suggested the importance of extending one's thinking about influences on mathematics teaching practice beyond beliefs about mathematics, mathematical learning, and mathematics teaching. Further, these researchers delved a little deeper into the investigation of teaching so as to understand the decisions that teachers are called on to make. Much of the time, mathematics educators focus on what influences classroom practice is with strict regard for teacher's beliefs and knowledge about mathematics and its teaching and learning (Skott, 2004). Studying teachers with a stringent focus on mathematics creates a narrow portrait of the complexities of teaching as well as the decisions that teachers are called upon to make. These studies illustrate the need to look beyond mathematics and its teaching and learning and into larger educational priorities as well as priorities specific to the classroom context to capture mathematics teaching practice. These studies provided a framework for my study in that I approached understanding my teachers' choice of practice with respect to the competing priorities they were forced to address at any given time. My goal was not to judge these teachers but to understand how they mediated the impact of teaching mathematics to different students in a tracked context.

One criticism of these studies is their vague stance on the influence of larger social issues. There is room for issues of race, class and gender in both Skott's and Jaworski and Patori's models of the different influences affecting teaching. One might imagine that *sensitivity to students* (Jaworski, 1994) might include sensitivity to student culture or socioeconomic status, but there is no explicit discussion in either study about the role that gender, race, or class plays in the decision making in mathematics teaching. It might have been that the studies were conducted in relatively homogenous research sites where social stratification was not apparent. In Skott's case, the study was conducted in a fairly homogenous setting in Western Europe. Another option is that these researchers did not want to add yet another layer to the complex nature of teaching. Sztajn (2003) does bring issues of social class into the conversation on priorities on teaching of mathematics.

The studies on teaching as decision making suggest that teachers have competing goals at any given moment. These different influences can create competing priorities for teachers. The teachers in the present study were veteran teachers teaching in diverse schools. Therefore, in talking about the competing priorities with which teachers cope, the needs of the students were paramount. That is, knowing what their particular students needed to be successful in mathematics should have played a role. Two of the three teachers in my study taught in schools with large Black student populations. The literature on culturally responsive teaching of Black students was also reviewed for this study.

Mathematics Teaching and Culturally Relevant Pedagogy

Over the past decade, scholars in education have contributed a small body of knowledge on successful mathematical teaching practices of teachers of Black students. Perhaps the most well-known study was the one conducted by Gloria Ladson-Billings (1995a) and had the framework *culturally relevant pedagogy.* In her study, Ladson-Billings located several qualities that characterized the teachers and teaching of Black students. She found that the teachers in her study maintained that their students (a) “must experience academic success,” (b) “[must] develop and/or maintain cultural competence,” and (c) “must develop a critical consciousness through which they challenge the status quo of the current social order” (p. 160). Since its creation, other scholars have used *culturally relevant* pedagogy to define that teaching style based on the knowledge of the culture of Black students. Tate (1995) defined *culturally relevant pedagogy* as “a pedagogy of opposition that builds on the thinking, experiences, and traditions of Black students....The primary purpose of culturally relevant pedagogy is to empower students to critique society and seek changes based on their reflective analysis” (Tate, 1995, p. 169). Allexsaht-Snider and Hart (2001) suggested that this type of pedagogy offers students a sense of belongingness in the mathematics classroom. They argue that the extent to which students engage in the classroom varies directly with the extent to which they feel important and active members of the classroom community. They suggest the importance of teachers connecting the mathematics to students’ lives particularly when the students are marginalized. Allexsaht-Snider and Hart argue that the culturally relevant pedagogical styles illustrated by both Tate (1995) and

Ladson-Billings (1995a), exhibit such meaningful strategies for making those connections. Although these studies offer a model for the type of teaching that might be beneficial to Black students, the guidelines are very broad, are not always content-specific, and do not include teachers in secondary schools.

Several studies have offered examples of the enactment of culturally relevant teaching of Black students in the mathematics classroom (Ladson-Billings, 1995b; Tate, 1995). Still others have offered examples of teaching for social justice, a major component of culturally relevant pedagogy, in a Latino mathematics classroom (Gutstein, 2003). In each of these studies, specific examples of teaching mathematics in culturally relevant ways are offered. I included this research because of a combination of ideas. For one, my participants were National Board Certified implying that they had demonstrated attention to the particular needs of their students. Secondly, they were teaching in diverse school settings with some population of students of color. Given the design of my study, it was conceivable that the characteristics of the students that my participants felt important were race/ethnicity, gender, or socioeconomic status. This literature on culturally relevant pedagogy was important in helping me define what I would be looking for in terms of their adjusting their teaching practice to accommodate for the diversity of their classroom.

Chapter 3
Methods

Research Design

The purpose of the study. The purpose of this study was to both describe and understand how high school mathematics teachers used their knowledge of students to adjust their teaching practice when teaching in various contexts. This study was based on the idea that teaching is a situated activity and can only be understood in context. In the following sections I describe choices/decisions that influenced the design of the study.

Use of qualitative inquiry. Qualitative inquiry methods were the most appropriate for this study as I strove to *understand* the role of their knowledge of students in the teaching practice of my participants. Using an interpretivist framework, my study attempted to understand teaching as a meaningful human action. Schwandt (2000) suggests that in interpretivist inquiry, "to understand a particular social action, the inquirer must grasp the meanings that constitute that action" (p. 191). The action that I strove to understand in my study was that of my participants' teaching of mathematics in diverse contexts. I used triangulation, an approach that "reflects and attempt to secure an in-depth understanding of the phenomenon in question" (Denzin & Lincoln, 2000, p.5). As triangulation calls for using varied data sources, I used classroom observations and teacher interviews to gain a better understanding of the knowledge of their students that teachers use to inform their teaching of different student groups.

Qualitative methods provided the large frame for my study, and more specifically, my research methodology drew on literature in three areas: social constructionism as a theoretical framework for research, case study, and researching the work of teaching.

A social constructionist approach to qualitative research. The theoretical underpinnings of this study were based on social constructionism. My study focused on how teachers constructed the differences between students in two classes different with respect to ability level and sometimes with respect to the level of mathematics as well. Additionally, my study sought to understand how these constructions of students in a tracked high school setting influenced how the teachers made sense of their mathematics teaching—explaining, answering student questions, and posing mathematical tasks (Ball, Lubienski, & Mewborn, 2001), which in turn affected their practice. This concentration on teachers' sense making of the act of teaching is informed by the assumptions on which social constructionism is founded. Social constructionism, influenced by a variety of philosophical modes of thought, is based on four main assumptions described by Burr (2003). These are the following:

1. Taken for-granted knowledge about the world based on observation must be troubled. For example, the ways in which we classify the world based on the so-called "nature" of the world must be questioned.
2. The way that we categorize and understand the world is based on both the culture and time in which we live.
3. Knowledge is created in the constant interactions between people during their everyday lives, not out of objective observations of the world.
4. The ways in which we construct and understand ourselves and others bring forth certain consequential actions.

Social constructionism rejects the idea of an objective reality and instead embraces the idea that language structures how we see ourselves and understand others. These language structures are inextricably linked to the society in which we live. That is,

> our ways of understanding the world do not come from objective reality but from other people, both past and present. We are born into a world where the conceptual frameworks and categories used by the people in our culture already exist. We do not each conveniently happen to find existing categories of thought appropriate for the expressions for our experiences. (Burr, 2003, p. 7)

Patton (2002) suggests that social constructionists "study the multiple realities constructed by people and the implications of those constructions for their lives and interactions with others" (p. 96). Thus, types of research questions investigated with a social constructionist framework include: How do participants construct their reality? What are the consequential actions to their particular world view?

Social constructionism's dependence on context, in particular, interaction with the social world is crucial to my study. A guiding assumption for the study was that the participants' teaching practices were informed by how they held knowledge of their students and understood the relationship between their students and mathematics. I view teaching in terms of decision making (Skott, 2001), and I see the act of teaching as being influenced by how teachers make sense of their students both on a micro-level, or inside the classroom, and on a macro-level in larger society. I argue that good teachers do not make decisions about pedagogy in an objective way with no concern for whom they are teaching or their particular needs. Crucial to a social constructionist framework is the influence of our construction of others and ourselves, as gathered through social interaction and influenced by the cultural and historical context in which we are living, on our actions (Burr, 2003). This study was founded on the assumption that the ways in which the participants understood their students and their students' relationship with mathematics would influence their teaching practice in a way that would be visible through observations of them teaching mathematics to two distinct groups of students. To study teaching in the context of the classroom I had to draw on social constructionism.

Capturing these differences in practice and understanding how they relate to knowledge of students was intricate work. Effectively studying such relationships required an in-depth inquiry. Case study, a common methodological approach in qualitative research, offered the best research design for such a study.

Case study. Ragin, Nagel, and White (2004) suggest three main components of qualitative research according to what they term a *minimalist definition of qualitative research.* They suggest that: (a) qualitative research: "involves in-depth, case oriented study of a relatively small number of cases, including the single-case study"; (b) it "seeks detailed knowledge of specific cases, often with the goal of finding out "how things happen (or happened)"; and (c) qualitative researchers have a primary goal of making facts understandable, "and often place less emphasis on deriving inferences or predictions from cross-case patterns" (p. 10). This idea of making phenomena understandable as described above as part of case study research, as opposed to trying to predict or infer, was central to this study of how teachers use their knowledge to adjust teaching practice. The focus on *how* as opposed to *why* made a case study method the most logical choice for my research design. Understanding *how* phenomena take place is a question that is better answered using the in-depth analysis called for by case study. In this study, a case study method allowed me to gain greater knowledge about how the participants used their knowledge of students and mathematics to inform and adjust their practice in teaching students in tracked classes.

I conducted a multi-case study of three National Board Certified Teachers (NBCTs) teaching mathematics in high schools with racially diverse student populations. Each case focused on the teaching of mathematics in two different tracks allowing me the opportunity to make between-case comparisons as well as within-case comparisons. Looking between cases at the intricacies of the particular contexts in which teachers are teaching can offer insight into how those contexts affect the adjustment of teaching practice. The search for similarities and differences to better understand and provide texture to a phenomenon is called *crystallization* and is a common methodological design in qualitative case study research (Ragin et al., 2004). In looking within cases for similarities and differences in teaching practice when teaching different student populations, I made a methodological choice that would help me to better understand how these teachers used their knowledge.

Although not all qualitative researchers agree that case study is a complete method, I adopt Yin's (2003) approach of seeing it as a means of framing an entire study from designing research questions to analyzing data. In this way, a case study method, one that describes a way of doing in-depth analysis of a few cases, informed the entire study, including the close relationship between study and context. Yin (2003) defines a case study as an "empirical inquiry that

- investigates a contemporary phenomenon within its real-life context, especially when
- the boundaries between phenomenon and context are not clearly evident" (p. 13).

Yin (2003) describes the strong relationship between case study research and looking at context as being part of the in-depth analysis. I approached investigating the phenomena of teaching by studying it in context. To answer my research questions, I strove to understand how the mathematical pedagogy of my participants was intertwined with the context in which they were teaching. Understanding how the teachers were using their knowledge of their students to adjust their practice required me to observe their teaching in each context and to interview them with respect to what occurred during their teaching. In so doing, the boundaries between the act of teaching and their classrooms necessarily overlapped.

The idea of studying teaching in context materialized through the use of a case study method but was informed by my review of the mathematics education research on teacher knowledge and teaching practice. In the next section, I describe how reviewing that literature influenced my choice of approach to understanding knowledge by studying teaching practice in the context of the classroom.

Capturing the Work of Teaching One of the main criticisms of research on teacher knowledge has been its oversimplification of the relationship between knowledge and practice (Ball, 2000). Studies that have reported on relationships between teacher mathematical knowledge as measured by courses taken or scores on basic-level standardized tests and student achievement do not provide insight into the nature of the knowledge that is needed for the teaching of mathematics. Similarly, studies that focus on teachers' conceptual understandings of particular mathematical topics, while illustrating the gaps in teacher knowledge, do little to help us answer the question about mathematical knowledge and other sources of knowledge requisite for teaching. These studies measure teacher knowledge by presenting their participants with either content-based tasks to probe their subject matter knowledge or hypothetical student errors to measure their pedagogical content knowledge (e.g., Even, 1993; Even & Tirosh, 1995). These tasks take teaching out if its context and remove the complexity of having to synthesize and call on knowledge while doing the work of teaching. Ball, Lubienski, and Mewborn (2001) suggest a third approach for investigating the knowledge needed for the work of teaching that focuses on practice as opposed to teachers. This third approach would:

> entail mathematical analyses of core activities of mathematics teaching. Those core activities include things such as figuring out what students know; choosing and managing representations of mathematical ideas; appraising, selecting, and modifying textbooks; deciding among alternative courses of action; and steering a productive discussion. Identifying the mathematical resources entailed by these teacher activities would be an important step to this approach. (p. 227)

Studies in this above described paradigm would analyze the teaching practice and discern the necessary knowledge needed for being effective. In this study of the knowledge used by secondary mathematics teachers in tracked classrooms, I adopted a methodology that allowed me to focus on the work of teaching. Though Ball et al. (2001) focus specifically on studying teacher knowledge as it relates to mathematics, mathematics teaching, and mathematics learning, whereas in the present study I investigated the contribution of non mathematics specific knowledge to teaching practice, their philosophy for studying teaching in context heavily influenced my choice of method. In particular, instead of providing teachers with hypothetical classroom situations and probing them on what they might do, I chose to conduct an in-depth investigation of their teaching through a methodology built on classroom observations and interviews.

Regarding teaching practice as a situated and complex activity to be understood through observing and then questioning teachers on their pedagogical choices is an approach used in many studies on teaching (Lampert, 1985; Macdonald, 1995; Skott, 2001). Skott (2001) conducted a study investigating what appeared to be discrepancies between a beginning teacher's beliefs about mathematics teaching and learning and his actual classroom practice. To capture the intricate relationship between the teacher's beliefs and his practice, Skott used a method based on gathering what he termed the teacher's *school mathematics image* (SMI), described as the teacher's "idiosyncratic priorities in relation to mathematics, mathematics as a school subject and the teaching and learning of mathematics in schools" (p. 6). He then used the SMI as a tool for analyzing observations and interviews with the teacher. This method allowed him to understand how a teacher's competing priorities can complicate the relationship between a teacher's practice and the teacher's espoused beliefs. Skott's study further illustrated the complexity of teaching. Studying teaching as a situated activity, Skott was able to show how during any given school day, multiple goals pull at a teacher and force choices to be made. The importance of his study for the present study was the choice to study teaching as a situated activity. In so doing, Skott was able to understand how the teacher's nonmathematical priorities interfered with his efforts to teach in the reform-based manner that he strived for.

Lampert (1985) used both a study of her own teaching as well and a study of another teacher to illustrate the decisions that teachers make during teaching. Often, as in the case of Skott (2001), these decisions may not be strictly mathematical, but they have very strong implications for the teaching of mathematics. Lampert wrote of these decisions in terms of dilemmas and teachers as "dilemma managers" who weigh the consequences of making particular choices in the act of teaching and struggle with making the best decision. These choices, she suggested, are not external but inextricably connected to the teachers' identity, their history, and what kind of teacher they strive to be. These dilemmas and the way that the teacher approaches them are extremely personal, but are not always anticipated. Studying teaching as a situated activity provides insight into circumstances that are foundational in a teacher's choice between competing goals and how that choice affects his or her mathematical teaching practice.

Approaching the study of teaching as a situated activity in which mathematics teaching is not the only concern of teachers in the moment allowed both Skott (2001) and Lampert (1985) to understand the practice of teaching. Further, they regarded teachers as quick thinking, reflective dilemma managers. Studying teaching in action and seeing decision making was an integral part of teaching informed the present study. The method included gathering information about the participants' goals for teaching mathematics and teaching their students. In the same way that Skott (2001) used his participants' *SMI*s as "an interpretive device" (p. 8), I used what my participants described as their goals, as well as how they described their students, to understand how they adjusted their practice when teaching two groups of students. I approached their practice as decision making in which they tried to adjust that practice to obtain their teaching goals based on how they interpreted their students' needs.

Participants

Participant selection I used a criterion-based selection process (de Marrais, 2004) to select participants for my study. It was important to my study that my participants be teachers who taught mathematics with some attention toward the particular students in their classes. That is, I did not want to use teachers who would not differentiate their instruction regardless of who they taught. I thought it necessary to include veteran teachers in this regard. In addition, I wanted participants who were at the very minimum competent with respect to subject matter knowledge and pedagogical content knowledge. To help in participant selection, I sought out National Board Certified Teachers. I also sought out such teachers who taught in schools with relatively diverse student populations. My criteria for selection were that the teacher had successfully obtained Young Adult/Mathematics National Board Certification, taught mathematics at the high school level, taught in a school that was sufficiently diverse with respect to having large numbers of minority students, and taught a mixture of lower-track and higher-track mathematics courses.

Why National Board Certified Teachers The creation of the National Board for Professional Teaching Standards was in direct response to the 1980s' publication *A Nation at Risk*. This publication on the less than satisfactory state of the country's education system provoked many reform efforts, including the creation of the document *A Nation Prepared: Teachers for the 21st century* produced by the Carnegie Task force on Teaching as a Profession. This document, supporting the teacher as the crucial factor in school reform, called for the creation of the NBPTS with goals of focusing on retention, acknowledgement, and advancement of good teachers, as well as learning from the expertise and knowledge of veteran teachers. The mission statement of NBPTS is:

> to advance the quality of teaching and learning by: maintaining high and rigorous standards for what accomplished teachers should know and be able to do, providing a national voluntary system certifying teachers who meet these standards, and advocating related education reforms to integrate National Board Certification in American education and to capitalize on the expertise of National Board Certified Teachers (NBPTS, 2002, p.2).

Focusing on the teacher as the major contributing factor to the improvement of student achievement, NBPTS developed a process of certification based on teachers providing evidence of accomplished teaching, as defined in the board-developed standards, through a series of self-reported assessments.

"Accomplished" is the term used by the NBPTS to describe those teachers who have successfully completed the National Board Certification process. These teachers are regarded as accomplished as they exhibit those qualities deemed crucial to successful teaching as defined by the NBPTS. These qualities are defined in detail as standards developed by the organization. The NBPTS' standards for distinguishing accomplished mathematics teaching (NBPTS, 2001) are based largely on the vision of mathematics teaching described in the NCTM *Principles and Standards for School Mathematics.*. The standards offered for the accomplished teaching of high school and middle school students are based on the idea that the mathematical competency that young Americans must have today is more complex than that needed by students in previous generations. The NBPTS standards are also built on the assumption that all students need to acquire mathematical proficiency as opposed to the elite few. These two ideas form the foundation for the NBPTS standards for accomplished mathematics teaching. In twelve elaborated guidelines, NBPTS, an organization comprised of mathematics teachers and mathematics educators, paints a picture for its vision of accomplished mathematics teaching. Recognizing the relevance of context to teaching practice, NBPTS acknowledged that accomplished mathematics teaching will not look identical in every school setting. However, the board advocated that

> certain guiding principles relevant to mathematics content and pedagogical knowledge are widely agreed on among mathematics educators. These guiding principles represent the common ground that unites accomplished teachers and distinguishes their practice without regard to their current assignment, school context, or past experiences. (NBPTS,

2001, p.14)

These principles are described in the standards.

For a high school or middle school mathematics teacher to achieve Board certification, their teaching and professional practice must align with the 12 standards offered by NBPTS to describe an accomplished teacher. Briefly, the framework offered for describing an accomplished mathematics teacher portrays the vision of a mathematics teacher who is focused on and knowledgeable about their students. This characteristic was of particular interest to me given my research questions. They are committed to their students' learning. An accomplished teacher has high expectations for every student. National Board Certified Teachers (NBCTs) have strong mathematical content knowledge and strong pedagogical content knowledge. Their knowledge of mathematics is broad and deep; their knowledge of students is both general and specific. NBCTs have general knowledge of students and student development and knowledge related to ways student learning is impacted by differential aspects including cultural background, home life, and ability. They are able to use this knowledge to choose between curriculum materials, teaching strategies, and assessment tools, selecting the most appropriate methodologies for their distinct student population. Specifically with respect to teaching mathematics, the accomplished teacher is able to create an engaging learning environment where students feel comfortable taking intellectual risks when sharing their thoughts and ideas in class. Accomplished mathematics teachers promote mathematical thinking in students.

Finally, accomplished mathematics teachers are reflective life-long learners. They are constantly reflecting on their teaching practice and continue to seek opportunities to learn more about mathematics, mathematics teaching, and mathematics learning to inform their practice. They work collaboratively with peers to improve or solidify their schools' academic program and support other teachers. The general description of accomplished teaching described above is based on 12 standards detailed in the 72-page national board certification document used to inform the portfolio entries of candidates.

The certification process has two aspects: self-reporting through teaching portfolios and a subject matter and pedagogical content test. In the portfolios, teachers provide videotaped examples of their teaching practice along with examples of student work. In addition, candidates submit written reflections to accompany each artifact. These reflections include justification for teacher action and their thoughts on the events that transpired during the teaching episode. The assessments on content allow teachers to demonstrate a flexible and broad knowledge of their subject.

Though the process of National Board certification has only gained significant momentum since 2000, research has been conducted on NBC teachers. Also, there is some amount of controversy surrounding the certification process. Earlier research has showed that students of National Board Certified teachers achieved greater gains as measured by end of the year achievement tests than those that do not. However, a most recent article suggested that these early findings were inaccurate. Despite the lack of evidence of the success of the process, some states such as North Carolina continue to support the process, while others have changed their policy on providing financial incentives for those teachers who gain certification. In Georgia, teachers applying for certification at the time that this study was conducted would only gain financial assistance if they taught in low-performing schools. The teachers in my study, all certified prior to 2006, were able to receive extra financial support as a result of their gaining certification.

Below I discuss some of the research on the National Board Certification process. This research includes, but is certainly not limited to *the effects of having a National Board Certified teacher (NBCT) in the classroom, qualities of NBCTs,* and *criticisms of the NB process.* If nothing else, this research supports my claim that the teachers in my study were well-decorated, reflective, veteran teachers who had demonstrated that they were, at the very least, more than competent in their jobs as mathematics teachers.

The effects of having a NBCT is the classroom. Many states working to comply with *No Child Left Behind's* mandate that each state find a way of ensuring quality teachers in their classrooms are looking toward National Board Certification (Vandevoort, Amerin-Beardsley, & Berliner, 2004). With more and more states looking to NBC, many critics have voiced concern about the monetary commitment required for the teacher and the state Teachers are required to pay over $2000 for the process, and many states are offering monetary incentives in the form of financial assistance for the application process. Others are instituting a pay-for-merit program based on the NBC in which teachers are financially rewarded for successful completion of the process. Some of those concerned wonder if a cheaper means of determining teacher quality might exist, given the perceived limitations of the process. For example, Ballou (2003) criticized the process for its one-sided approach to defining quality teaching. NBPTS has come under criticism for not being able to provide evidence that having a National Board teacher in the classroom does really improve student achievement. Given these criticisms, several large-scale studies have been conducted studying the validity in using NBPTS standards as a means of defining teacher quality. These studies have been mainly quantitative and have compared student standardized achievement test scores of National Board Certified Teachers (NBCTs) with non-

NBCTs and NBC candidates who were unsuccessful in attaining certification. I will summarize the findings of these few large-scale empirically-based studies.

Goldhaber and Anthony (2004) conducted a study in North Carolina that specifically focused on the effects of having a NBCT as compared to a non-NBCT and a NBC candidate who did not successfully attain certification on elementary student achievement growth. Using gains on a statewide standardized achievement test as the measure of student growth, the study revealed that while there was a non-significant difference in effect between gains for students with NBCTs and non-NBCTs, there was a statistically significant difference in effect between students with NBCTs and students with unsuccessful NBC candidates. Goldhaber and Anthony (2004) concluded that "The primary reason for the differential between certified and uncertified teacher applicants is that teachers who apply to the program but are unsuccessful in their attempt at certification are actually less effective than non-applicant teachers" (p. 17). That is, those teachers who are successful in demonstrating qualities and qualities of teaching in line with the NBPTS' standards for accomplished teaching are more effective as teachers as measured by gains in students' achievement scores compared to those teachers who may have applied for NBC but failed. This study supports NBPTS's claim to have provided an assessment process that skillfully identifies accomplished, high quality teachers.

In a similar study, Vandervoort et al. (2004) studied the relationship between the adjusted gain scores of elementary students in Arizona on the Stanford Achievement Test – 9th Edition (SAT-9) during a four-year period and the NB status of their teacher. Unlike Goldhaber and Anthony (2004), Vandervoort et al. compared only NBCTs to non-NBCTs and not intentionally to unsuccessful candidates. Using a .10 effect size to indicate an equivalent gain of roughly one academic month, they found that in all four years, students of NBCTs made greater gains than students of non-NBCT teachers. However, these gains were statistically significant for only three of the four years. The effect size measured in terms of months ranged from a half month gain to 3 and one-half months gain for students of NBCTs compared to students of non-NBCTs. Overall, they found that students of NBCTs had higher gains about 73% of the time, while non-NBCTs had higher gains about 25% of the time. However, the gains of the non-NBCTs were not statistically significant for any cases. In analyzing the effect size, Vandervoort et al (2004), supporting the claims of Goldhaber and Anthony (2004), found that having a NBCT gave students a gain in achievement equivalent to one month. Again, it might be noted that the differences in effect size might have been greater had they distinguished between NBCTs and non-successful NBC candidates. However, both studies indicate that students of NBCTs have greater advantages in terms of achievement on standardized tests than students with non-NBCTs. A third study (Cavalluzzo, 2004) conducted in Miami Dade County showed similar results. Controlling for student and school characteristics, the researcher found that students of NBCTs had greater gains than both students of non-NBCTs and unsuccessful NBC candidates. Again, the difference in gains was greater between students of NBCTs and unsuccessful NBC candidates. Additionally, the variation in effects of NBCTs on student population subgroups was studied. Cavalluzzo compared effects with respect to the race of students as well as other student characteristics. She found that the effect size was statistically significant and greater for Hispanic and Black students, suggesting that these students might truly benefit from having a NBCT in their classroom.

The "typical" NBCT Obtaining certification requires that NBCTs exhibit qualities and their teaching exhibits qualities in line with the characteristics the NBPTS suggests define accomplished teaching. Outside of these qualities, research studies have found that NBCTs overwhelmingly exhibit particular qualities that suggest they are well-decorated teachers. Vandervoort et al. (2004), in their study of the relationship between NBCTs and student achievement, found that 88% of the NBCTs in their study held masters' degrees, and 80% had taken additional coursework beyond their bachelor's degree.

Other relevant descriptive statistics reported about NBCTs include that their students are more likely to be White and gifted, less likely to have had an out-of-school suspension, have a lower absence rate, are less likely to repeat a grade, and have a higher grade point average (Cavalluzzo, 2004). Students in lower-income, higher-minority schools are less likely to have qualified teachers in their classrooms as compared to their more affluent White peers (Darling-Hammond, 1996). It is no surprise then that NBCTs are more likely to be in a classroom teaching a class of White, middle-class students than Black or Latino students in high-poverty schools. Humphey, Koppixh and Hough (2005) provided demographics describing the distribution of NBCTs in schools. In looking at demographics for six states–California, Florida, Mississippi, North Carolina, Ohio and South Carolina (these states represent 65% of the NBCT population)–they found that 16% of the population worked in high-minority schools, 12% taught in high-poverty schools, and 19% taught in low-performing schools. The majority of these teachers teaching in poor, minority, or low-income schools did so in California. In the remainder of the 5 states, NBCTs were seriously underrepresented in such schools.

The number of NB certified teachers in the country has grown dramatically since its first year of certification in the 1993-1994 academic year. In its initial year there were 177 NBCTs in the country. Ten years later, during the 2003-2004 school year, there were 8,065 NBCTs certified. That is an increase of more than 400% (NBPTS, 2004). Additional states are offering incentives for teachers to obtain certification. More teachers are opting to go through the NBC process over obtaining master’s or specialist degrees. Many teacher education programs are integrating the NBC process into their teacher preparation programs. While National Board has attracted plenty of criticism, most critiques are directed at the process. Opponents argue against it as a fool-proof method of determining teacher effectiveness. Research shows that having a NBCT is the classroom gives students an advantage over students without a NBCT or with an unsuccessful NBC candidate. NBCT tend to have more teaching experience, higher degrees and have surpassed the state-mandated requirements for teaching certification. A review of the research reveals that NBCT are high-quality teachers whose students grow academically in their care. Unfortunately, there are few such exemplary teachers in America caring for the academic success of Black students. As Cavalluzzo (2004) reported, Black students may gain the most from such teachers as compared to their White counterparts.

It is with careful consideration of the above literature and my own experience working with NBCTs that I have chosen to conduct my study on teaching with these teachers. The teachers in my study were held in high esteem in their schools, often serving as department head or a lead teacher, had taught for many years, held master’s degrees and a doctorate in mathematics education, were reflective on their teaching and dedicated to their students. My study is based on the assumption that these NBCTs were very good teachers, thoughtful in what they do, with strong mathematics backgrounds and intimate knowledge and concern for their students. Given the few NBCTs teaching in school districts with large minority populations, I used teachers in several school districts. I identified more than school districts with at least one NBCT certified in Young Adulthood/Mathematics (ages 14-18) in the metro-Atlanta or Clarke County area. I narrowed this list of districts to those with fairly diverse student populations. Using the Georgia Department of Education website as a source, I identified four districts that served a diverse student population in terms of race. In particular, I looked for districts educating a student population comprised of somewhere between 1/3 and ½ Black students or Latino Students. In those four districts, using the GADOE website, I located the high schools in each district with diverse student populations. That is, high schools that had somewhere between 1/3 and ½ Black students in their student population[1]. Once I identified prospective school sites to conduct my study, I researched whether any of the NBCTs in high school mathematics were employed at those sites. In total, from 4 districts, I identified 10 who taught at those schools. I contacted all of the ten and received positive responses from 7. Once I received the positive responses, I sent out a survey asking the teachers which classes they were teaching. My criterion for participation was the teaching on two different tracks – that is teaching one honors course and one lower-level course. I had to eliminate one of the seven because she was teaching all lower-level Algebra I. Two others were excluded because time constraints would preclude me from conducting interviews with them. I was unable to gain approval in a timely manner from one school district, such that in the end I used three participants. The three that I chose in the end for the end fit the criteria of being NBC in Young Adulthood/Adolescent Mathematics, teaching in a diverse high school, teaching two different ability levels, and willingness to participate.

Data Collection

Main data sources. In trying to understand the participants' goals for mathematical teaching I begin the inquiry with interviews. Qualitative interviews are used by researchers to gain an understanding of a phenomenon based on the words of the person who has experienced it (de Marrais, 2004). In my study, I used interview data to understand how accomplished teachers

[1] The GADOE reported demographics from the 2004-2005 school year at the time that I was doing participant selection. Two schools' demographics had changed during the last school year such that at one, the fraction of Black students was more than ½ and at another the Black population had fallen slightly below 1/3. I still used both schools as research sites because the individual classes of the teachers still fulfilled my criteria.

described using their knowledge of students to adjust their practice in teaching diverse groups of students. I used interview protocols to guide the semi-structured, formal interviews with the participants. Given the diversity of the participants, I changed the interview questions during the interview as I saw fit.

I conducted three types of interviews with each participant. In the first interview I asked the teachers to describe the students in the two classes that I was observing. From this interview, I wanted to gain information on what knowledge they had of their students and to what extent that knowledge was racialized. In other words, I wanted to know to what extent the race of the students would be included in the ways they described each class. In this interview, I asked the teachers to describe what they knew about the students in these two classes. I also asked what characteristics of their students they felt were crucial to their planning of lessons, choosing textbooks, assigning homework, and assessing. In conducting this interview, I hoped to determine what information about their students my participants felt was relevant to their teaching practice. I also asked them to describe the differences and similarities between the groups of students in the two classes that I would observe. In asking them to compare the two groups of students, I wanted to understand the characteristics of the students they were using in adjusting their teaching practice between the two classes.

In the first interview, I also questioned the teachers about their general goals for mathematics teaching. I used the term *priorities* taken from Skott (2001) to describe those explicit focal points for teachers in teaching mathematics. The term *priorities* attempts to capture the conscious decision making that is crucial to teaching. I asked for a general description of their priorities for mathematics teaching to help me understand the participants' larger ideas about teaching mathematics. Those ideas helped me focus on the similarities between the two classes observed as I looked for how the teachers' priorities were present in the teaching of the two classes. Through this interview, I also gathered information from the teachers about their priorities for the two classes I observed. This information helped to set the stage for what I observed in the two classes.

Interviews of the second type, also open-ended and semi-structured were conducted weekly such that for each participant I had a collection of several of these second types of interviews. Sometimes these happened informally right before or after class or during lunch. These interviews were phenomenological because phenomenology is considered the best method for clarifying "the foundations of knowledge in everyday life" (Berger & Luckmann, 1996, p. 20). In keeping with my social constructionist framework, the goal in these interviews was understanding the reality of everyday teaching as well as the role that knowledge played for these teachers. During these interviews, I drew the teacher's attention to a particular teaching incident in class. I questioned the teacher about his of her actions and choices at the incident. The first two types of interviews helped me to answer my second research question.

In the third and final type of interview, I asked questions about the teachers' teaching background, including teacher preparation and the National Board Certification process. I conducted only one of this type of interview. I asked specific questions about the diversity of their schools and how that diversity affected their teaching or classes. It was through this interview that I really wanted to understand how teaching diverse student populations affected their pedagogical decision making.

The observations of the teaching were conducted shortly after the initial interview. The teacher wore a lapel microphone so that I could record what the teacher said as well as teacher-student interactions. These were transcribed along with the interviews. The observations were used to capture incidents in the participants' teaching to use as points of reference for the second types of interviews. I observed the teaching of two classes each day for 2 weeks. Each of the classes was on a different track depending on the structure of the particular school.The observations allowed me to compare each participant's teaching in two different classes and to answer my first research question. I observed each participant with special attention to the work of mathematics teaching (Ball et al., 2001); that is, posing problems, facilitating discussion, informal assessing, and explaining.

Data Analysis

My approach to data analysis was based on general induction. I followed Bogda & Biklen (1992) who wrote:

> As you read through your data, certain words, phrases, patterns of behavior, subjects' ways of thinking, and events repeat and stand out. Developing a coding system involves several steps: You search through your data for regularities and patterns as well as for topics you data cover, and then you write down words and phrases to represent these topics and patterns. These words and phrases are *coding categories*. They are a means of sorting the descriptive data you have collected (the signs under which you would pile the toys) so that the material bearing on a given topic can be physically separated from other data. Some coding categories will come to you while you are collecting data. These should be jotted down for future use. Developing a list of coding categories after the data have been collected and you are ready to mechanically sort them is, as we shall discuss, a crucial step in data analysis (p. 166).

Starting with the first research question, I examined the interview data to create codes that categorized the ways in which the teachers were describing the differences between the two classes. Using a multi-case study approach (Yin, 2003), I took each teacher as an individual case and coded each one separately, creating a list of codes for each of the teachers.

I used the first interview as a tool to analyze the classroom observations. Following Skott's (2001) approach to analyzing his data, I used the mathematics teaching priorities espoused by participants as a means of analyzing the observation data. In so doing, I was looking for similarities between the teaching of the two classes as well as similarities between the teaching and the espoused mathematics teaching priorities. I was looking for relationships between the participants' knowledge of the students in their two classes and their pedagogical choices and how those differences in teaching styles fit in with the teacher's priorities in teaching. In a manner similar to Skott (2001), I utilized "what appeared to be the value judgments and educational priorities in these visions" (p. 245) to interpret what I was seeing in the different classrooms.

Chapter 4

Data Analysis

In this chapter, I my interpretation of the data and bring out some major themes both within cases and between cases. Two of the three research questions provide headings, with the relevant data presented for each participant under each question. The third research question on the role of race has been incorporated into the discussions of the other two questions. I thought it better to include race in the responses to the other questions because the three teachers did not see it has having a role in their classroom. I saw it playing a role, however, particularly in the ways in which some of the teachers talked about differences between the two classes. Instead of giving race its own heading, I use the data to show how it is necessarily intertwined with my participants' talk about their students.

I begin with a brief description of each participant's teaching history, his or her philosophy of teaching, and the demographics of his and her classes and of the school. I also provide a general description of the two classes that I observed each participant teaching. This information provides a context for their interview and observation data. In these descriptions of participants the actual names of the teachers and schools are not given; pseudonyms were used. In the succeeding sections where I present the data, pseudonyms are used for student's names, as well.

Description of Participants

Kerry Marks. Kerry Marks was a 26-year veteran mathematics teacher with 21 years of experience in teaching high school mathematics. She attended the same school as the one in which she was teaching at the time of the study. A White teacher from Georgia, she spoke of her involvement in her church regularly in class. Her daughter was a top student at the school and her son had graduated previously. Kerry held a master of education degree as well as endorsements in gifted education and Advanced Placement statistics. She earned National Board Certification in 2004. During the study she taught Algebra I, College Prep Geometry, and College Prep Advanced Algebra and Trigonometry at Magnum Springs High School, a large high school in northeast Georgia. Magnum Springs High School was a fairly diverse school with 64% Black students, 22% White students, 7% Hispanic, 2% Asian, and 2% multi-racial. Close to half, 55% of the school was eligible for free and reduced lunch.

Kerry characterized her approach to teaching as guiding her students through the process of learning mathematics.

> I try to be very relaxed about making students feel comfortable. I also want them to be able to show their understanding about the mathematics by being able to discuss it. So as I begin to teach, I want to go from points of reference that they're familiar with. We need to find some common ground to begin with. Then we try to spring from that. I try to make explanations as we go, though there are times where I want them to discover some things, so I might put them in a situation where everything is not explained. But the philosophy is that you make everyone feel comfortable, and they take baby steps. Then they are able to put together not truncated pieces of information but a massive body of knowledge that's useable in an everyday kind of situation….trying to help students to understand though mathematics can be incredibly complex—that if we take it in small snippets and build our knowledge that they can actually be able to maybe not remember every single detail but be able to have a working knowledge of what makes sense

> mathematically and what doesn't make sense. I kind of build their logic in the middle of all that.

Kerry used the word *paraclete* which she likened to a guide, "a person that comes alongside and guides them." She said that while she knew that it was more fashionable these days to think of oneself as a facilitator in the mathematics classroom she found that the role she had to play required much more than facilitating. She often had to metaphorically take the students by the hand and lead them. Based on my observations of her teaching, I would describe Kerry's mathematics classroom as teacher-centered but inclusive of student input.

During the year that the study was conducted, Kerry played an active role in the mathematics department's efforts to standardize the Algebra I program at Magnum. The school experienced a 50% failure rate in Algebra I, which was similar to the state rate of failure for the course. In its attempts to remedy the situation, the mathematics department decided to adopt a plan in which all teachers of Algebra I (13 teachers in total) were working as part of a professional learning community to write tests collaboratively as well as to work together to create objectives for the course.

> Our whole math department is working on a professional learning community right now, based on some research that I've unearthed. We are trying to help our passing rate. We have about a 50% failure rate, 50% passing rate, whatever you want to call it. That's about the national average in Algebra I. It just seems like around us in the state of Georgia, everyone else is passing and not our kids. So you know we're trying to work on that.

Kerry and the other teachers relied heavily on the 90-90-90 school literature—a group of studies looking at schools that experienced 90% student achievement as measured on tests with a student

population that was 90% minority and 90% free and reduced lunch. The department met regularly to discuss content, assessment, and pedagogical strategies for ensuring student success, and to swap war stories on what had been working and not working. This attempt at ensuring a higher passing rate for the course created clear-cut curricular goals for the Algebra I course. Beyond the more content-based goals, the students were expected to be able to perform well on the state end of course test for Algebra, which the students would be expected to take at the end of the second semester of Algebra I. Kerry said she was facing a real struggle with the other teachers as she tried to get them to buy into the idea that the students needed flexibility in working with the concepts. That is, she spoke of the importance of students being able to write about the mathematics as well as to answer questions that are not so "flat cut and dried". She gave the following example of what she intended by flexibility in mathematical thinking:
"So I ask a lot of questions that are backwards-thinking kinds of questions. 'Create a two-step equation so that the solution is *x* equals 2' instead of my giving them the two-step equation only and asking them to answer." Kerry classified these questions as being outside of the realm of the more basic or foundational problems that students were typically given in Algebra I.

The Algebra I class was about two-thirds ninth graders taking the course for the first time and one-third repeaters taking the course for the second or third time. The class was about 70% Black students and 30% other. In a class of 20, there were 14 Black students and six non-Black students, including several Hispanic students. The students sat in desks that were grouped in three sections—each section with about three rows and four columns—so that Kerry could walk around easily to each student. She let the students work together during the class period, and this arrangement of seats allowed the students easier access to each other. From my observations of the classroom, a typical day included a test prep assignment that students were supposed to begin working on when entering the classroom. The test prep usually comprised questions on material that was covered the previous class period. Students worked on this individually for a few minutes and then Kerry asked for volunteers to put the answers on the overhead projector at the front of the room. The activity after the test prep changed from day to day, but typically there was some sort of group discussion of a problem led by Kerry followed by individual or group work on a similar problem. Kerry walked around during the individual work time to help students with problems or to just check on their progress. At the end of class, Kerry would go over the answers with the class and then assign homework.

The Advanced Algebra and Trigonometry class proceeded in much the same way as the Algebra I class. This course had a College Prep title attached to it; however, College Prep is the middle-track course at Magnum Springs High School, with Advanced College Prep being the highest-track and Tech Prep being the lowest course apart from Special Education. The Advanced Algebra and Trigonometry course was composed mainly of juniors and seniors for whom this course would be the last mathematics course taken in high school. The class of 30 had 11 Black students, 3 Hispanic students, and 16 White or Asian-American students. Kerry expected that all of the students in the class would continue on to college. The goals for the course, as described by Kerry, were focused on preparing students for college-level calculus. The course attempted to pull together everything mathematical that the students had learned in algebra and geometry, to give them a broad understanding of high school mathematics and its usefulness. Time constraints prevented Kerry from covering all of the course material. For Kerry, this was okay because the goal was to

> at least give them an overview of what it takes to be ready to go into a calculus class. These really are the same objectives that the pre-calculus class at UGA [The University

> of Georgia] has. We used to teach in 18 weeks what UGA was doing in 9 or 10 weeks. Now we are teaching in 18 weeks what y'all are doing in 12 weeks of class, but with a good bit more help and explanations of things.

Right away, it was easy to understand a difference in the goals for the two classes. For one, the looming end-of-course test and Kerry's department's resolve to ensure that more of their students passed Algebra I that year created a more rigid content outline for the Algebra I class. That the students had to pass the exam at the end of the two semesters of Algebra I meant that Kerry not only had to cover all of the material on the exam but cover it in a way to ensure that the students understood the concepts flexibly enough so that they would be successful on the exam. However, the Advanced Algebra and Trigonometry class, with no end-of-course, exam was just a survey course with what described as "no new material". The point of the course was to provide the students with proper preparation for Calculus I in college. Kerry also taught the Advanced Algebra and Trigonometry classes for the previous few years, so she had a lot of experience with the course as well as many materials to use. Her goals for the course along with her history of teaching it seemed to allow Kerry to be more relaxed in this class than in the Algebra I class.

Amanda Lipton. Amanda Lipton was the mathematics department head at Eastside High School in Atlanta. During the time of the study, Amanda was in her eleventh year of teaching at Eastside. Amanda, a White woman, was from Michigan and had attended college there. As department head, Amanda attended a regional meeting of the National Council of Teachers of Mathematics (NCTM) in 2005 to learn more about assessment. She attended this conference out of departmental concern for Eastside's students' scores on the mathematics portion of standardized tests for the past year. The school failed to make Adequate Yearly Progress (AYP) because of the students' scores in mathematics. In efforts to improve test scores, Amanda sought professional development opportunities with the intention of bringing back ideas to her department. Eastside High School served a more than 80% Black student population and a 59% rate of student eligibility for free or reduced lunch. Eastside also included a music magnet program. At the time of the interview, Amanda taught one class of Honors Pre-Calculus and two Regular Advanced Algebra and Trigonometry classes.

As the school was 84% Black, the demographics of the two classes that I observed, Honors Pre-Calculus and Regular Advanced Algebra and Trigonometry did not differ much with respect to race. The Honors Pre-Calculus course had 18 Black students and 2 Hispanic students. The Advanced Algebra and Trigonometry class was 100% Black, with 18 students. There was, however, a difference with respect to gender between the two classes. In the Honors Pre-Calculus class, there were 2 boys out of 20 students as compared with 5 boys out of 18 students in the Advanced Algebra and Trigonometry class. Although there were more than twice as many boys in the middle-track class, the lack of male participation in the upper-level mathematics courses was indicative of a school-wide problem. Amanda suggested that this difference in gender was comparable to the differences in graduation rate with respect to gender. Every year at graduation there were far fewer males graduating than females.

Amanda's preparation for teaching included a bachelors' degree in mathematics from Michigan State University. After completing the initial degree, she had stayed a fifth year to obtain teaching certification through the mathematics education program. During her time in the program, Amanda had the opportunity to work with prominent mathematics educator Glenda Lappan. Amanda attributed her philosophy of teaching to her learning experiences in the program, including a year-long practicum.

> So I think my education preparation was wonderful, you know, and the classes, the methods classes and the ethics classes, and all those types of things that we did, they really did prepare me….It gave me a really firm foundation of what good teaching is supposed to look like, and what it's supposed to be. And while I didn't do it my first year, you know, you at least knew where you wanted to go and what you wanted to do.

Amanda described "good teaching" as based on constructivism, a theory of learning she became familiar with at Michigan State.

> J: Describe your role as a teacher.
>
> AL: And this is so Michigan State, this is where I got it—very constructivist in the way I teach. I believe in giving the kids at the beginning of a topic something to think about—something to look at. And then we kind of develop the topic and keep building on to it as we go through the unit. I don't believe in telling them everything. I believe in giving them the tools to discover ideas on their own. And I don't see myself as a lecturer, although there are days when all I do is problems. But I mean, there are times when you just have to answer questions and facilitate the learning. But I do see myself much more as a facilitator in the classroom. Getting the groups to work—giving them activities to develop the content. I really think a lot about how they're going to make sense of something. I try to think a lot about how they can make a connection to what they know in their world.

Amanda saw herself as a facilitator and described trying to make her students see mathematics as useful and connected to their worlds. Likewise she tried to promote self-discovery of mathematical rules or patterns. For example, during my observations, Amanda did a lesson with both classes that involved their using a graphing calculator to look for patterns in transformations of functions. She gave the students the parent function and had them graph transformations of the function. The students then compared the functional notation and graphs of both the parent function and the transformations of the function. The activity ended with a whole-class discussion of the general form for the different transformations of a function. In both classes, Amanda made sure to give students an appropriate amount of time to think about a problem. She also encouraged them to talk to each other about the problem. In general, Amanda tried to avoid being the source of mathematical information and instead urged both classes of students to think about the mathematics for themselves as well as to look to their neighbor for help.

> Sometimes I say talk to your neighbor or you can ask one other person to help you and things like that. It gets the kids giving me the answers. It should be the students doing the math, not me. I think something we fall into when we're rushed because of objectives is that we're the only ones doing the mathematics , and the kids aren't doing any of it.

Amanda's general goals for teaching mathematics centered on making sure that the students were talking about the mathematics, that the classroom was student-centered with the students doing the mathematics, and that the students saw the mathematics as relevant to their lives.

Amanda's goals and approaches to teaching for the two classes were different and based on several factors, including which track the class was on as well as the class size. For example, the Honors Pre-Calculus class included many students who had been on the honors track for several years, and she had been their teacher for Honors Geometry and Honors Algebra II. Since these students were in their third mathematics course with her, they were used to her style of teaching—one based on questioning students as opposed to telling them. Amanda said of them, "They don't know any other way of learning math than having a lot of questions about it—which

I think is a good thing." She reported that her use of collaborative work depended on the size of her class. For example, one of her classes had well over 30 students, making it difficult to use collaboration effectively. However, the two classes that I observed were much smaller so she could use collaborative work extensively.

Another influential factor was that Amanda was preparing the students in the Honors Pre-calculus class to take AP Calculus, the next mathematics course in the Honors track. In doing so, Amanda described how she tended to spend a great deal of class time and out-of-class time having the students justify answers and talk about why when solving problems. For example, Amanda gave an assignment to the class in which they had to prove that five mathematical propositions about the unit circle were true. The original task as given in the textbook just had the students determine whether each statement was true or false. Because of Amanda's concern that her Honors students be able to justify and describe their thinking, she changed the textbook assignment to include providing a justification or a counterexample.

The Advanced Algebra and Trigonometry class was on the college preparatory track; however, the name of the track did not necessarily imply that the students in the class were advanced. Amanda described how the school had eliminated the applied track a few years before, and so many of the students in the Advanced Algebra and Trigonometry class should actually have been in a more applied-level mathematics class. What this opinion implied for the teaching of the course is that Amanda focused mostly on content but did not delve as deeply into it as she would have in the Honors course. She admitted that while she tried to keep the Advanced Algebra and Trigonometry course to a certain level, she spent more time illustrating examples than she did in the Honors class. She described the difference between her approaches to the two courses as: "[In] Honors, the most popular question is 'Why does it do that?' [In] Advanced Algebra and Trigonometry, it's more 'What do you see?'"

Peter Norris. Peter Norris taught at Lakedale High School in Northern Atlanta. Peter was a White male originally from England. Lakedale housed International Studies Magnet and International Baccalaureate (IB) Programs for students in the district. These programs created an interesting mix of students attending the school. As the school was located in a fairly affluent area of Atlanta, the student body included students who came from upper-middle and upper-class families. Also, as the school bused in students who did not live in the school's surrounding area but had been admitted to the Magnet or IB program, there were other students, particularly Black students, from all over Atlanta in the student body. Lastly, the zoning of the school included a predominately Hispanic, lower-class portion of the city, so those students were also in attendance. During the 2005-2006 school year—the year that this study was conducted—the student population was 35% Black, 48% White, and 17% other, including Asian, Hispanic, and multi-racial. Free and reduced lunch eligibility was 27%, almost half that of the other two schools. Although the racial makeup of the school was diverse, Peter described the socioeconomic status of the students as less than representative of the economic diversity of the nation. Further, the students, in particular the African American student population stood out to him because of the emphasis placed on education in their families.

> We are heavily weighted towards the wealthier end in all groups except the Hispanic groups. Our African Americans tend to be middle- and upper-class African Americans who bus here because their parents don't want them to be in the predominately African Americans schools in the south county….We act as a bit of a school to attract those parents in the African American community who tend to be educated themselves, who

> still live in their community in the south of the county but want their kids to be in a more academic environment….Our African American kids don't have the attitude that it's cool not to be academic. We have a lot of ambitious African American kids….The county buses them, but some of those kids are leaving home at half-past 6 in the morning, the bus picks them up, and they're traveling 50 or 60 miles. Because if they live in the more affluent southern suburbs, which are still largely African American down there, they still bus them up here. So that bus comes at 6:30 in the morning.

Peter painted a picture of a student population in which close to 80% of the population – the Black students and the White students—came from middle-, upper-middle, and upper-class families in which the parents were educated and pushed their students academically. At the other end of the spectrum, the school educated poorer Hispanic students who lived on "the border of our community" in apartment complexes. This student population had grown over the past several years and was less likely to succeed academically. Peter said that the school had failed to meet AYP the previous year because this subgroup of students did not achieve adequately in testing. These Hispanic students were visibly missing from the two calculus classes that I observed Peter teaching.

In general, all the students in Peters' classes were college bound. On the higher end of the spectrum, the AP Calculus class contained not only eleventh graders who had taken Algebra I in seventh grade, therefore making them well advanced past the requirement of Algebra I in eighth grade, but also a few tenth graders. Peter described how every year he had maybe two or three exceptional tenth-grade students sitting for the AP exam. Many of these students had participated in a special program at Duke University based on exceptional SAT scores achieved while in middle school. As part of the program, the students had the opportunity to advance mathematically so that they could take calculus as sophomores. Lakedale High School contained a very talented student pool.

Peter's background included a PhD in mathematics education, and during the time of the study, he was also teaching content courses at a local university for practicing elementary school teachers. Peter had completed a degree in engineering in England, where he was originally from, before coming to the United States to teach high school mathematics. His approach with his students incorporated lots of joking and teasing. The students made fun of him, and he in turn made fun of the students. The jovial rapport between the students and Peter created a comfortable and laid-back atmosphere in both classes.

The two classes of Peter's that I observed for this study were both Calculus I classes. Lakedale had two versions of Calculus—AP and regula which fell in the middle-track. The regular class was mainly seniors who had taken Geometry, Algebra II, and Pre-Calculus at Lakedale. The AP Calculus consisted of mostly eleventh graders who had taken Geometry in middle school and Algebra II and Pre-Calculus in high school. There were two seniors in the AP Calculus class. The regular class was 30% Black and 70% non-Black, but mostly White. The honors Calculus class was 10% Black and 90% non-Black, but mostly White. Peter described the mathematics tracking for the district as fairly rigid. In seventh grade, advanced students took Algebra I, so that they were on track to take AP Calculus in eleventh-grade. Average or Regular students took Algebra I in eighth grade and were most likely to take Regular Calculus as seniors. If the students were below grade level, they would take Pre-Algebra in eighth grade and then Algebra I at Lakedale.

The topics for the two classes were basically the same. The difference, for Peter, lay in the goals. The regular Calculus class was the last mathematics class the students would take before college, and because it was not AP and the students would not be taking the exam to earn college credit for the course, they would be re-taking the course in college. On the other hand, the AP class had a different goal because Peter had to prepare the students to be successful on the AP exam. Peter said:

> Well, the ambition of each class is different. One, they're [the AP class] aiming for an external examination where on the day of the exam they are going to have 30-odd multiple-choice and 6 open-response questions they have never seen before. So I am trying to train them to be able to cope with a problem in an environment which will be stressed in one more familiar. Whereas with the Regular Calc, what I am trying to do there is give them a survey of the fundamental ideas of calculus so that when they have to take [a] Calc. class in college, they don't know what's coming in terms of details, but they've got a fundamental idea of what we're trying to achieve.

Peter described how these different goals in turn influenced the way in which he structured the courses.

> I want the AP to be challenging and it doesn't matter if it's an unfriendly environment to them. Whereas the regular class, I want it to be something that makes them enthused and interested because they don't need a class in their senior year which is intimidating and unfriendly. Because they don't have to take it. They've all got enough credits. And if you make it that way, they will resent it, and you won't get anything out of them. Whereas in the AP, you have always got this over your head.

In general, the AP class was conducted more rigorously than the regular class.

Table 1 School Racial and SES Demographics

School/Teacher	Black Students	Non-Black	Free and Reduced Lunch
Magnum Springs/Kerry	64%	33%	55%
Eastside/Amanda	84%	16%	59%
Lakedale/Peter	35%	65%	27%

Table 2 Class Racial Demographics

Teacher	Class Type	Black	Non-Black
Kerry	Advanced Algebra and Trigonometry	33%	67%
	Algebra I	70%	30%
Amanda	Honors Pre-Calculus	80%	20%
	Regular Pre-Calculus	100%	0%
Peter	AP Calculus	10%	90%
	Regular Calculus	30%	70%

The History of Tracking in the Schools

Amanda’s and Peter’s middle-track mathematics classes –Advanced Algebra and Trigonometry and Calculus – were still considered advanced in terms of content. The students in these classes would fall into the category of strong mathematics students if the category were defined by the highest-level mathematics course taken in high school. However, Peter and Amanda still claimed that the students in their lower class were weak mathematically. They qualified the claim by suggesting that just because the students were taking college preparatory classes did not necessarily mean that they were good students. Peter said:

> To be quite honest, you think in terms of regular, but if you go back over the past, those regular kids weren't college bound. What have we done in the last 40 years? We've changed from a small group who are college bound, and the majority who graduated at high school, and a group that dropped out. And we've shifted that up now, so we have an honors class that are going to the better colleges, the advanced central block that are going to the equivalent of [a] 4-year college, or a 2-year college and then a 4-year, [and] then those who are going to graduate but leave. So when you look at those kids in that regular calculus class, they've gone a long way. They've achieved a lot. They have to be considered less mature in their learning and their desire to learn.

Peter suggested that as more high school students had ambitions of going to college, the college preparatory courses such as Calculus, which before had been taught to the elite few, were now being opened up to be more inclusive. Amanda described a similar situation with her regular Advanced Algebra and Trigonometry class. She suggested that the presence of students "misplaced" in the college preparatory course prevented her from making the class as rigorous as she would have liked.

> The Advanced Algebra and Trigonometry class is the same content [as the Honors Pre-Calculus class], but it's on the regular level. It would be considered a college prep course. Um, the difference that I see in it—there are a lot of kids in the Advanced Algebra/ Trig class that are misplaced. They don't belong in Advanced Algebra /Trig. We got rid of our applied level courses a couple of years ago. So we don't teach Applied Algebra, Applied Geometry. We teach Algebra I, Geometry, Algebra II. But what that means is all those kids that do belong in the applied level are ending up in the regular level. So then they end up in Advanced Algebra /Trig somehow. So I have kids that made 70s in Algebra I

now taking Advanced Algebra and Trigonometry and they don't have the skills they need for it. So it's not as rigorous as I would like it to be.

With their schools making the move to more inclusive college preparatory classes, Peter and Amanda noted that in so doing, the preparation of students in the classes was lower than what might be expected of students taking an advanced mathematics class like Advanced Algebra and Trigonometry or Calculus. Kerry's school had also made a similar move by creating an Advanced College Preparatory track, so that the average student who might have been previously placed on the Technical Preparatory track at her school would now be on in College Prep classes, with the truly top students taking Advanced College Prep. Kerry, however, did not talk about this phenomenon lowering the preparation of students in the college prep courses.

Three Teachers in Different Contexts

The three participants—Peter, Kerry, and Amanda—were chosen because of the very different nature or their schools as well as their classes. Peter taught in a school in which students in his two classes were mainly middle class and had a great deal of parental support. Further, students, eleventh graders and twelfth graders, were taking Calculus in high school, a feat only 12% of all high school graduates in the United States accomplished in 1998 (National Science Foundation, 1998). Although Amanda taught classes comparable to those Peter taught, the students in the classes were very different. Amanda taught in an inner city, predominately Black high school with 59% student eligibility for free or reduced lunch. However, many of the social problems associated with inner city schools, such as gangs or high drop-out rates, Amanda reported, were not visible in her higher-level mathematics classes. By the time a student made it to this level of mathematics, such social issues were not such a problem. Those students who were involved in extra-curricular activities such as gangs would have dropped out before reaching that level of mathematics.

Kerry's situation was different from Peter's and Amanda's in that although she taught a higher-level mathematics course with college-bound seniors in her Advanced Algebra and Trigonometry course, she also taught an entry level Algebra I class composed of freshmen who either did not take Algebra I in middle school or did not successfully complete the course in middle school and older students who were repeating Algebra I for the second or third time. Kerry's school was the most ethnically and racially diverse of the three. The comparison of students in her two classes offered the most pronounced lack of racial parity with the percentage of Black students in the Algebra I class far succeeding the percentage of Black students in the more advanced class.

Though teaching in very different contexts, the teachers were similar with respect to how they constructed the groups of students as well as how they approached their teaching of the different classes. However, as expected, their different contexts provided some interesting distinctions as well. In the next sections, I report my findings for each of the three research questions and discuss similarities as well as differences between the three cases with respect to their particular context.

In order to use Oakes' (1985) research as a framework for analyzing my data, it is important to be in agreement about terminology, especially when it comes to defining higher track, lower track, and average track. Oakes uses each of the three as an amalgamation of different titles for the same type of courses. For example, lower track might include vocational or technical preparatory courses. Higher track might include AP, honors, or gifted courses. Average track might be regular courses. Using my participants' descriptions of the course and its positioning in the school curriculum, I incorporated Oakes' terms. Given both the context of the school in which my participants were teaching and given the difference in time during which Oakes' data were collected and the present, I made some modifications in Oakes' definitions. For example, based on the following quote, Oakes might have described both Amanda's Advanced Algebra and Trigonometry course and Peter's Regular Calculus course as higher-level mathematics.

> As in the English classes, the average math classes were considerably more like the high-track classes in their content than like the low. And too, the content of average math classes can be considered a diluted version of that of the high classes. This was especially true at the junior highs and through about grade ten at the senior highs. From that point on in our schools, math was usually no longer a required subject, and only what would be considered high-track classes were offered to those students wishing to go on in math (p. 77)

However, given both Amanda's and Peter's separation between their regular classes and the Honors or AP version of the class, I feel comfortable in defining these classes as average-track. Further, both teachers described how their schools eliminated the lower-level track and suggested that the students in the non-Honors class were not considered on a par with the Honors or AP students. With this same reasoning, I characterize Kerry's Advanced Algebra and Trigonometry class as an middle-track class.

Kerry's Algebra I class is more difficult to define because of the mixture of the students in the class. Some of the students were ninth graders who had not passed Algebra I in eighth grade or had been placed in Pre-Algebra in the eighth grade, and otherwise older students who either had failed Algebra I and were retaking it or had been placed in Pre-Algebra as ninth graders. Thus, the class is better understood in terms of where the students might go next. Some of the students could go on to take the second-track regular class, termed College Preparatory Euclidean Geometry, after completing the course. Others would go on to take Informal Geometry, which is a lower track course than College Prep Geometry. It is the lowest track Geometry course, but because it is not required for the lowest track diploma, a technical preparatory diploma, it is not considered the lowest tier. Of the rest of the students, those who passed would go on to earn a Technical Preparatory diploma, the lowest level diploma, which required only Pre-Algebra and two semesters of Algebra I. These students were mostly those who were repeating Algebra I for the second or third time. Kerry predicted that only one-fourth of the students in the Algebra I class that I was observing would go on to take the second-track Geometry class, with the rest remaining on the third and fourth track. Therefore, I would consider this class a mix of lower-track and average-track students.

Research Question 1:

What knowledge of students do teachers use to inform their teaching practice?

Lack of Academic Maturity in the Lower Track Class

Differences with respect to maturity in the two classes were reported by each participant. Under academic maturity I include any traits having to do with motivation, self-discipline with respect to schoolwork, willingness to stay on a teacher-directed task, and ambition to be a successful student. In general, each participant thought that the students in the lower track class were overall less mature academically than their peers in the higher track class.

Kerry. With Kerry, I was initially concerned about comparing the two classes with respect to motivation or maturity because one might assume that the Advanced Algebra and Trigonometry class, with mostly juniors and seniors, would of course be seen as more mature than the Algebra I class, with mostly ninth graders. However, when I brought up this concern, Kerry assured me that academic maturity was not necessarily defined by age. She told the following story:

> And so we've had an interesting situation here at school in that a man who used to, not teach in the math department, but, he was on staff here as a teacher, became the person in charge of all of our custodial staff for the county. He says he's just moved from having those same troubles about no homework, no excuse, not on time, can't come to class, all that kind of stuff. He said it's the same kids that he taught some of them are the exact same kids that he taught with those issues as ninth graders 15 years ago. And now here they are adults, and they're still having the same issues. So when I say maturity, I'm not even sure putting 10 more years on them that that's going to change a whole lot. I don't know how you motivate a person to – it's almost like a point of integrity, more than anything else and pride in yourself and self esteem and self worth.

Kerry talked about maturity not in terms of biological age but added to it this notion of being self-directed and motivated. Although it may develop with age, her example of the custodian suggested that it is not necessarily that with age comes maturity—at least not in the way that she was thinking of it. With respect to this definition of maturity—motivation, determination, pride and integrity—Kerry described the differences in maturity level between her two classes.

After telling the story of the custodian, and talking about the same group of Algebra I students, Kerry was pessimistic about a student's ability to change if he or she did not have self-direction. While she gave students a new chance each day to make a change, she admonished that "it is the rare child that is able to make that leap from sort of wandering aimlessly." On the other hand if students were more mature, even if they got off task a little, they could always get back on. She gave the example of a student in the Advanced Algebra and Trigonometry class:

> I have one student who I told him he was going to have to get off the zero train because he just kept collecting zeros in a row. [He was]very capable, and so he came and saw me last Tuesday afternoon. He said, "I'm going to change my ways." And he's had all of his assignments since then. He can decide "I'm going to change and be different." He'd just kind of gotten off a little bit.

Kerry went on to suggest that this orientation to goals and ambition was characteristic of the students in the Advanced Algebra and Trigonometry class. She then compared these qualities with those of the Algebra I students; in particular, the Algebra I students who were older and were repeating.

> That's the thing that's alike about that group [Advanced Algebra and Trigonometry] is that they have the inward motivation and purpose to maybe not make an A every time, but they see the goal in sight—graduating, going on to college. They have other goals for themselves. Whereas a lot of students in that Algebra I [class] that are struggling are there for the second and third time. I don't think they have a sense of direction.

A lack of maturity or direction can keep students from learning. Kerry suggested that it was often a lack of maturity that kept her Algebra I students—not all of the students, but the ones who were repeating the course—from being successful. She attributed their failing the course not to their lack of mathematical ability but to a lack of academic maturity.

Amanda. Amanda's Honors Pre-Calculus students were both motivated and driven to succeed.

> They want to succeed. They want to have As in the class, and it's an honors class – I don't give As away very easily in that class. They're very driven, and if you give them a group activity, they will dive into it and go into it immediately.

Also, because these students knew that doing homework would result in good test grades, they put forth effort in doing the homework. This was not characteristic, Amanda felt, of the regular students, who were far less motivated.

> The Advanced Algebra and Trigonometry kids, they just—You know, some of them have an idea that they're going to go to college, but they're just going to be the kids in the remedial math classes in college. They're just not—they don't have the study skills. They don't have the drive to get those types of things done.

Amanda described having to monitor the regular students, who were less likely to complete a task in class unless she was walking around checking on them and who would not do homework unless it meant that they would receive a grade for the assignment. Amanda said of the two classes:

> When we did that activity at the end of class yesterday, you heard several of them [Honors students] ask, "Are you going to pick this up?" And I said no. If I had said no to my Advanced Algebra and Trigonometry kids, they would have stopped—they would have not done it. But my Honors Pre-Calc, they're like, "Oh, okay, that just means I don't have to write it real neatly. I still need to do it to get the concept, but I don't have to write it out all nice and pretty." And that's fine – yeah. But the other kids need a little bit of checking.

Amanda found herself having to provide more test preparation for the regular students compared with the honors students because the regular students were less likely to progress toward mastery of the subject throughout the unit. Alternatively, Amanda described the honors students as working hard throughout the unit to understand the material as opposed to waiting until right before the exam.

> They're asking their questions along the way and making sure that they understand it along the way, whereas the lower level kids won't do that. They won't prepare for a test until the day before the test unless you tell them….Whereas the Honors kids – they're in here every Tuesday after school for an hour working in groups and asking the questions and making sure they understand it.

Amanda painted a picture of hardworking, self-motivated Honors students working toward mastery of the subject as opposed to the regular students, who required constant external motivation.

Peter. There was a difference with respect to both motivation and behavior between the AP/Honors calculus and the regular calculus class as described by Peter. The motivation of the regular students was far inferior to that of the AP students, who Peter described as being "pushed harder." In particular, the regular class contained some unmotivated students who had "decided that they don't want to do AP." That is, there were students in the regular class who Peter thought should have been taking AP calculus but chose not to because, although bright, they were "not willing to be stressed out in their senior year."

> It's not that they don't want to do AP for the right reasons: which are [that] they don't want to do AP because they want to be successful in another class. [It's that] they don't want to do AP because they would rather do an easier class.

Several of these students caused a real problem for Peter because they were too bright to be in the regular class and were thus easily distracted. One student, Laurie, continually caused problems in the regular class.

> Laurie—she has no right being in that class. I am not going to confront her about her behavior, because it's a losing battle. As long as she is not disturbing anybody else. So she'll sit there and she'll read a book. She's going to ace the class. She can get it in the same 5 minutes, same as the AP kids can….I'll only do something when she's distracting others.

Peter understood that Laurie was very bright and should have been working at a higher level, but because of her lack of motivation she had opted to take a regular class.

On the other hand, Peter suggested that the AP students were definitely working harder as they tried to learn material necessary to pass the AP exam. Whether this motivation was intrinsic was not clear. Peter made several comments about the AP students' parents understanding the financial consequences of their students failing the exam. It might be that Peter felt that the AP students were pushed at home to pass the exam and that in turn provided an external motivator for the students. Regardless, Peter suggested that differences in motivation existed.

Closely related to issues of motivation were issues of behavior. All three teachers reported having to manage the lower track classes with respect to discipline more frequently than in the higher track classes.

Different Behaviors

Kerry. Kerry's Algebra I class had markedly worse behavior than the Advanced Algebra and Trigonometry class, which in large part she attributed to the "repeaters" in the former class. Kerry confided that two of the biggest behavior problems in her class, two male students who were taking Algebra I for the third time, had already been removed for bad behavior. The removal of the two made some difference, but overall Kerry was troubled by the lack of discipline in her class, as indicated by the following excerpt from one interview.

> I shouldn't ask you this- but they [Algebra I students] were all pretty well behaved today? For what they could be and what we have seen in that class. Those two boys being out of there in particular is very helpful, and then the young man who's exceeded his absences, because they keep things kind of stirred up.

Kerry saw behavior as a crucial requirement for learning. In her role as teacher, she said that often she found herself guiding the students with respect to behavior because their behavior would often get in the way of their learning.

> Behavior—classroom management—becomes such a huge issue in that you can't learn, I can't teach, help them learn, whatever you want to call it, if there are all these other distractions. And so classroom management doesn't just mean you want them behaving well and alert and listening. They can't be asleep; they can't be writing their other work or even writing a letter to, you know, their girlfriend, or something like that.

Although both classes had some amount of misbehaving—Kerry admitted that—she saw a qualitative difference between the types of misbehavior in the Algebra I class and those in the Advanced Algebra and Trigonometry class. Although the Advanced Algebra and Trigonometry students might misbehave, the disruptions were generally innocent, and it took little for her to get the class back on task. Making excuses for misbehavior in the higher classes was common among all three participants. Behavior problems in the higher classes were seen as harmless and easily fixed. For example, a student in Kerry's Advanced Algebra and Trigonometry class was talking on her cell phone during class. Kerry politely told the student to put the cell phone away.

She described the girl as being agreeable and willing to comply. If a similar incident had taken place in the Algebra I class, Kerry mused, the incident might have gotten out of control, with the student responding defensively: “There’re a lot more behavior issues in Algebra I, where at any time it could become a volatile situation. So I am very aware of our adversarial, my adversarial role with them.” In contrast, with the Advanced Algebra and Trigonometry class, Kerry described situations in which she might have to nudge and the students might complain, but her relationship with that group of students was more congenial. On the other hand, in the Algebra I class she had to be careful not to create or facilitate possible explosive situations.

Peter. Peter suggested that both of his classes had the tendency to be distracted and get off task while working on an assignment. Both classes were likely to engage in conversations about topics not relevant to mathematics. He attributed this trait to their being teenagers. However, he found it much easier to get the AP students back to work even if they had a minor moment of distraction. The regular students were more difficult to refocus.

> You have to be more controlling of a regular class. Not because of an education need; it’s more because of a discipline need. With an AP class, they’ll get—they’re both equally like any group of teenagers—any excuse to be distracted is fine. It is a click of a finger to get an AP class back on track. It’s a real problem once you let a regular class go.

Peter attributed discipline problems in the regular class to, among other things, students’ lack of motivation and their frustration with not understanding the material in class. For example, Peter suggested that Laurie, the student he described earlier as opting out of taking AP Calculus because of laziness or lack of motivation, was an instigator of disruption during the class.

> If you notice, whenever I let them go a little bit, [Laurie] has that whole group around her who are then socializing again. She's the leader, and she doesn't need this time to learn. She's learned it, so she wants to be distracted.

That is, Laurie and students like her who needed less instruction and time to understand a mathematical concept were getting the other students off task. This disruption constantly caused Peter keep tabs on these students. In one classroom observation, Peter called on Laurie to stop talking to those around her constantly. At the other end of the spectrum, those regular students who did not understand caused discipline problems too. Peter saw their disruptive behavior as being linked to the frustration they felt in not understanding the material.

> A lot of your discipline problems turn out to be because you are asking [the regular students] to do tasks that they can't do. So they become antagonistic, and it comes out in all sorts of ways.

On the other hand, Peter suggested a different theory for the AP students:

> PN: I expect the AP kids to be extroverted and to be easily distracted and unwilling to do any sort of deskwork during class.
>
> J: Is that from experience?
>
> PN: Yeah, that's from experience. They just won't sit down and do an exercise in the classroom. As soon as you say, "Right, now do these problems," they will take it as a signal for social time, especially if you say, "I want you to do these problems together and discuss them."

That is, discipline problems in the AP class stemmed from giving students busy work as opposed to the regular class, where giving students difficult material might cause them to get off task.

Amanda. Amanda's discussion of behavior was similar to Peter's. She did not fear that the regular students would become explosive or combative in the way Kerry described, but she did admit that the regular students were more likely than the honors students to get off task and talk about something unrelated to mathematics. Amanda echoed Peter's claim that the behavior issues in the AP class were often due to the students' unwillingness to do non-challenging work. When the honors students got off task, for example, during an activity in which they worked in small groups to create different representations of the major concepts of trigonometry, Amanda suggested that she should have provided more challenging tasks. She noticed that one group whose task it was to create a word wall using the vocabulary words from the unit were constantly talking about non-mathematical related topics. She suggested that she needed to think of something more challenging for that group to do. On the other hand, when the regular students were off task during an explorative activity with the graphing calculator, Amanda stopped the activity short. She spoke during the interview about their off-task behavior that day, suggesting that it was due to their late-night homecoming activities during the previous weekend.

All three teachers suggested that behavior problems took place in both classes; however, they suggested that there were differences with respect to behavior problems between the two classes. For Kerry, it was the nature of the behavior problems. The Advanced Algebra and Trigonometry students were harmless in their misbehavior, whereas the Algebra I students were possibly explosive with theirs. For Peter, the difference was in the root of the behavior problems. In the regular class, disruption grew out of material being too far above their ability, whereas in the honors class, insufficiently challenging material was the cause. In general, all three teachers feared the lower students getting off task for fear that they would never be able to bring them back.

Different Mathematical Ability and Confidence

As might be expected given the different tracks of the two classes, all three teachers commented on the differences in mathematical ability between the classes. In general, each participant commented on the weaker mathematical skills of the lower-track students. A general complaint was that the students in the lower-track class retained less material from previous classes and they were forced to spend more time reviewing the material. In the higher-track class, less if any review was needed. Amanda summed up this thought by saying:

> The Advanced Algebra and Trigonometry [class] really wants me to do a lot more examples….They're just—their algebra skills are so weak. They are just so weak that its just—It's a challenge to—You know, it's just a daily challenge to get through the content that I want to get through because I'm going back to old stuff so much. You know the first unit is—I call it the function unit. We look at what a function is. We look at linear systems with matrices. We look at polynomial functions with quadratics in there, too. That's all review. That's all stuff they've seen before. You'd think that they'd never seen it any bit of it. But it's all stuff they've seen before, and they try. Some of them try to pull that, "Well my teacher didn't." And I'm like, "Uh Uh, no. Your teacher taught you quadratics in Algebra II. It's the biggest topic in there. You just didn't pay any attention to it."

Peter suggested that the difference in ability accounted for his spending more time on a topic in the regular calculus class than he spent on the same topic in the AP class.

> I'll make assumptions about their mathematical knowledge in the AP class, which I won't in the regular. Even the most basic things I will detail in explanation in the regular calculus class. If I am solving a quadratic equation, I'll go through the whole process of

how do you solve a quadratic equation. In the AP class I say, “And you solve this equation,” and assume that they can do it. I don’t hesitate to just go on and do it, and then move on through the rest of the problem. Which is why we take about a week to do in the regular class what we do in the day in the AP class. Very similar material, but in fact [although] they pretty much the same material, [it is] just going to take a long time over each one with the regular calc. And the thing that I’ll do also is I’ll work the problems with the kids in the regular [class], whereas in the AP I am going to do the typical, “Here’s an example, you solve problems,” type exercise.

Kerry corroborated the claims made about weaker mathematical knowledge in the lower track class, but she offered an additional weakness in confidence that she found in the lower track students. She found that the lower-level students lacked mathematical assurance or confidence in their ability to do mathematics.

Kerry. The lack of confidence came up several times with Kerry when she was describing her Algebra I students. She said this lack of confidence in the Algebra I class was a reason that she often did not provide the students with open-ended activities. The following excerpt from an interview came after I had asked her about an activity she described giving her Advanced Algebra and Trigonometry class in which they had struggled to apply a previously learned concept to a new problem. Kerry described the frustration the students had when they first began working on the problem. I asked her if she had or would ever provide for her Algebra I class the same opportunity to struggle.

J: So would you try something like that to that extent of kind of, “okay we’ve done this, now you struggle through something very different,” with the Algebra I class or the Geometry class?

KM: I might do that in Geometry. I probably would not let it go that far in Algebra I simply because most of the time those students will just shut down and just not do [it]….I probably would not do that in all in Algebra I, simply because even my very best students just put their pencils down and look at me when they don't have an idea. And I couldn't say that blankly—I should say I have probably two students in Algebra I that would go on and work on things.

J: But the rest?

KM: But the rest, even students that have As and Bs would just quit and just look at me.

J: Is that kind of what you see as a maturity thing?

KM: I think it's a maturity thing. I think it's a confidence issue—a great deal of it. A confidence issue.

The students' lack of confidence made them reluctant to share their thinking with both her and their peers for fear of appearing ignorant.

> I think I term—a lot of times in Algebra I—it's almost a face-saving. They don't want to appear to not know; they don't want to appear to be wrong. You can see in geometry, they're not that at all. They don't care about that at all. In Algebra I, and I don't teach a Pre-Algebra, I have taught Pre-Algebra many, many times. It is more of a, um [pauses] thing of their appearance and how appearing to be bright or not in front of others. Whereas often we just learn so much by what you're not supposed to do, by what our mistakes are. And so as a result I only have a few students that will go to the board, will go to the overhead, will answer out.

To accommodate students such as the ones described above, Kerry used several techniques in class. To encourage students to share their solutions and answers with their peers, Kerry had students show their answers on whiteboards. She also made use of activities in which the students had to solve problems and then find correct answers that were already provided on the activity, but in scrambled form. Kerry thought these methods helped encourage the students and helped to build their confidence in their thinking.

In contrast, Kerry did not talk about confidence or lack of mathematical ability in her Advanced Algebra and Trigonometry class. Instead, she attributed frustration or struggle in that class to students' unwillingness to work very hard during their senior year. Echoing Peter's complaints about certain misplaced students in his regular calculus class, Kerry described her Advanced Algebra and Trigonometry students as bright but too lazy to work.

> I find that most of the students in here—I've taught many of them before in geometry in particular—do not want to work that hard. Its not that they are not bright enough by any stretch of the imagination. And there is a level of frustration. Sometimes they just shut down because of "This is a little more than I want to think of right now."

Amanda and Peter. Neither Peter nor Amanda talked in detail about lesser confidence of the students in their lower-track class. It could be because both Amanda and Peter were teaching higher-level mathematics courses even if they were not on the highest track. Perhaps to even sign up to take Advanced Algebra and Trigonometry or calculus, the students had to possess some amount of faith in their mathematical ability.

Forming Relationships with Students

All three participants talked about being able to relate to their students as well as establishing some sort of relationship with them anchored in trust and comfort. Both Peter and Amanda were able to form relationships with students in both classes. Kerry, on the other hand, was unable to do so with the Algebra I class though she considered herself successful with the Advanced Algebra and Trigonometry class.

Peter. For Peter, humor played a major role in his interaction with his students. Sarcasm, a trait that he attributed to his English heritage, formed the basis for his interaction with his students. He picked on them, and they in turn picked on him.

> I'll tease everybody mercilessly. They just think its part of, "he's just that funny Englishman." It's funny because sarcasm is a big part of English society, and sarcasm is very frowned upon in education in America. When I first got here, they said, "You can't be sarcastic," and I said, "But I thought we respected everyone's tradition." Sarcasm is my tradition. So that's my cultural difference. The kids just like it; they don't see it as being—I find that if I'm not, if I'm straight all the time, they find it, "What's he mad about?" So that's it. They are bringing their own cultural knowledge from TV about the English into the classroom, which I'm responding to quite happily. So when I say, "That was a really dumb remark," they think, "Well, yeah maybe it was." They don't go, "Oh what's he talking about?"

Peter said that he established the same jovial rapport with all of his students regardless of the class. Based on my observations of his classes, I saw that to be true. He was able to joke around with both classes, and they were quite happy to respond accordingly.

Amanda. Amanda was a White teacher from Michigan teaching in an inner city majority Black high school in Georgia. Coming from Michigan, her first year of teaching, Amanda found that the cultural differences between herself and the students took some getting used to. However, as time went on, she said that she learned about their culture, and they learned about hers. The relationship that she formed with her students seemed to be based on mutual respect and genuine interest in learning more about each other.

> And it's been very interesting for me to, you know, learn about a different culture and get into that different culture but still keep my own identity. And you know, the kids want to know about my life, and about how I grew up, and what I did. And you know—we laugh about Michigan State jokes. You know, they come in on a test day in a U of M shirt, and I make them turn it inside out. So you know [laughs], and they know that I want to be here. And I think that makes a huge difference in my classroom.

During the study, Amanda wearing a Michigan State University shirt on College Day, talked to both classes – Advanced Algebra and Trigonometry and Honors Pre-calculus about her experiences in college. She answered questions that the students had about college and about her life as a college student. In addition to learning about her students and having her students learn about her experiences, Amanda told me that she loved working with the students at the school. In particular, she liked working with students who were Black, from the inner city, and with low socio-economic status. Forming the basis of her relationship with the students, she said, was that they all knew that she wanted to be there and that she held high expectations for them all. She seemed to have the same rapport with students in both classes.

Kerry. Kerry was the only participant who expressed some concern with not being able to connect with all of her students—in particular, those in her Algebra I class. She mentioned several times the way in which her students in the two classes—Algebra I and Advanced Algebra and Trigonometry related to her—that is, how they interacted with her and saw her role in the classroom. In general, the Advanced Algebra and Trigonometry students were much "friendlier". She once described them by saying, "They're a friendly group to work with, though the friendliness can get out of hand occasionally." In contrast, the Algebra I class was not as congenial. She gave the example of an incident that happened in her Advanced Algebra and Trigonometry class and compared it with what might have happened if the incident had taken place in the Algebra I class.

> I don't know if you noticed, but there was a girl with long hair, and they were working on the small assignment that was only supposed to take 10 minutes but took them 25 minutes. I noticed her head was turned and she was talking on her cell phone behind her long hair. I walked over, and they're not supposed to have cell phones out, and I said, "If I see it out again, I'll have to take it." "Yes ma'am." It was just -- I probably would have had a big huge situation with another student if it had been in algebra class. That's what I mean, the peer group in there [Advanced Algebra and Trigonometry] is so less looking at me as a disciplinarian as much as I am somebody to help them and guide them and that sort of thing.

The students in the Algebra I class did not view her as a supporter but as an adversary. Kerry suggested that there were some students that did not "connect" with her and that she did not "connect" with them. In particular, she described one male student in her Algebra I class who would not interact with her at all.

> KM: I have some students that will never ever even talk to me. They're not angry with me they are just – I can think of one student – he has told me yes before or no before in a yes-no situation where you might answer. But he will not answer in words to me about anything—even though he's got correct work in front of him. Or if he's stuck on something he doesn't want me to help him.

Tying the students' reluctance to connect with her to a lack of confidence, Kerry suggested that the students, especially the ones that did not interact with her might have been afraid of appearing to not know the answers. Whatever the reason, Kerry's claim that her relationship with the students in the Algebra I class was adversarial was verified by my classroom observations. At several points during the Algebra I classes, I observed Kerry having confrontations with students. She also had confrontations with students in the Advanced Algebra and Trigonometry class, including the one with the girl on the cell phone and another when she told a student to wake up, to which he responded with a statement like, "Why are you calling me out?" However disrespectful, Kerry did not feel that these instances where as potentially explosive as those in her Algebra I class. In general, Kerry, thought that she could relate better to the students in the higher-track class, told those students stories from her life, talked to them about her children and their accomplishments in going to college, talked to them about their own college aspirations, and gave them general advice about paying for college. The equivalent of such nonmathematical conversation was not observed in the Algebra I class.

Discussion

Before I discuss the data on my first research questions I summarize the major points of difference for each teacher between the two classes.

Kerry—bright but lazy class versus an underconfident and possibly volatile class In summary, Kerry described teaching two very different classes. Her Advanced Algebra and Trigonometry class, while looking for the easy way out during their senior year, was basically bright, with college as a definite goal. The class was diverse, yet the students were basically homogenous in terms of ability and motivation. Although Kerry had to push them a bit to engage in the mathematics, in the end they stuck with a task and completed it. The Algebra I students provided a more difficult situation. Kerry's main concern was their lack of confidence, which often led to the students shutting down if a task was too difficult. Kerry also talked about differences with respect to motivation and behavior between the two classes. In general, she found that her Advanced Algebra and Trigonometry students were bright and ambitious with aspirations of going to college, which indicated an inherent drive. They might get off task or occasionally exhibit poor behavior, but Kerry found them reasonable and friendly towards her so that a simple nudge would get them back on track. On the other hand, the Algebra I class with ninth graders and repeaters contained weaker students with low self-confidence. If a task proved too difficult, they were apt to stop working for lack of motivation and lack of confidence in their mathematical ability. The behavior problems that she had in the Algebra I class were much more serious than those in the Advanced Algebra and Trigonometry class. By the time of the study she had already had to remove permanently from her class two boys who continually caused disruptions. In addition, the Advanced Algebra and Trigonometry class was a capstone class bringing together all the different areas of mathematics that she thought the students had already learned in Algebra I, Algebra II, and Geometry, and Kerry saw the goal of the class as to prepare students for their next step, college. She did not worry about not covering all of the topics because the course was more of a survey course to introduce them to ideas. Algebra I, however, called for a bit more concern as Kerry and the other mathematics teachers were working towards ensuring a higher Algebra I passing rate for the school. The students had to understand the concepts to pass the end-of-course test.

Amanda – a driven class versus an unmotivated class. Amanda, whose teaching was based on the constructivist approach she learned as a preservice teacher at Michigan State University, strove to facilitate her students' learning without telling them what to do. Her two classes – Advanced Algebra and Trigonometry and Honors Pre-calculus—contained almost identical content. However, the goals of the two courses were different. The students in the Honors Pre-Calculus class had to be prepared to take AP Calculus. For Amanda, that meant the students needed to be comfortable and proficient at describing their solutions to problems and the processes they used as well as justifying their results. Differences in mathematical knowledge played a huge role in how quickly or deeply Amanda treated the content. With the regular students, Amanda spent more time reviewing concepts as the students were less likely to have retained previous mathematical knowledge. The main difference between the two classes was that the students in the honors class were more driven. Amanda painted a picture of hardworking self-motivated honors students working toward mastery of the subject as opposed to the regular students who needed constant external motivation.

Peter—a not too challenged class versus a class in over their heads Between the students in the AP and regular versions of Calculus, Peter found differences in mathematical knowledge, behavior, and motivation. In particular, the differences in both motivation and behavior led Peter to approach the teaching of the classes very differently. The AP students required a bit more challenging lesson so as not to be bored with busy work but then also to prepare them for the rigors of the AP exam. On the other hand, the regular students, some of whom were lazy and others of whom might become easily frustrated with complex mathematical tasks, got a classroom experience that would not stress them terribly during their senior year. Peter found himself having to compensate in the regular class for those students who truly would have been better served in the AP version of the Calculus course. These students, easily bored and possibly disruptive, called for Peter to be constantly watchful of their behavior. Making the work more challenging, while it might have solved the problem of the advanced students in the regular class finishing their work early would have caused behavior problems from the students at the other end of the spectrum, who, frustrated with their inability to do challenging work, would then become disruptive. Level of content difficulty was not of concern for Peter in the AP class because he wanted the material to be challenging so that they would be well prepared for the AP exam. He was not worried about creating a friendly environment in the AP class and instead strove to make it uncomfortably challenging.

Theme 1: similarities in thoughts across the three participants. Peter, Amanda and Kerry taught in three very different schools with different student populations; however, all still made a distinction between their tracked groups of students. For each, no matter if it were a Algebra I class or a more advanced Calculus class, the students in the lower-track class were described as lazy, nonmotivated, more apt to behavior problems, and often less mathematically capable. Although we might expect these descriptions from Kerry, who was teaching what one typically thinks of as a lower-track mathematics course, Peter and Amanda used similar terms to describe students who were college bound and taking advanced mathematics classes. One reason for this phenomenon might be that as Peter and Amanda claimed, the students in regular-track, but junior-level mathematics courses were only there because of a more inclusive policy on entrance to college track classes. Maybe the students did not deserve to be there. Peter and Amanda had each taught for more than a decade; maybe they had seen a change in the type of student taking these advanced content, but regular-track classes. Maybe the differences between the higher-track and the regular-track were growing as college preparatory classes were becoming more inclusive.

Another possibility is that each participant was drawing on a combination of reality (what they actually see in their classroom) and on their constructions (Boaler et al., 2001) of the students based on their placement in a particular track to define their students in the two classes. As we will see in the data for the second research question, constructing the lower-track students in this way had some strong consequences for the mathematical experiences offered to them.

Theme 2: behavior and classroom climate. Another theme that emerged was the association that each participant made between behavior issues and the lower-track students. In Kerry's case, behavior was a major issue in the Algebra I class. I conducted my classroom observations in October. She had already had two students permanently kicked out of the class for behavior problems. During my observations, there was not one day that she did not take a student outside to talk to him or her about behavior issues. Again it is important to ask, were the students in the Algebra I class that much more disruptive than her other students, or was she being influenced by their position as lower-track students who require more structure and discipline (Oakes, 2005)? I suggest, using as support the literature reporting that Black students are more likely than White students to incur accusations of being disruptive and hostile (Skiba, Micheal et al., 2002), that race played a role in Kerry's construction of her Algebra I students as being **more** disruptive than her Advanced Algebra and Trigonometry students. In particular, given the literature on how behavior and race are often intertwined as well as the differences in racial demographics between the two classes, I was aware of the way that Kerry's talk about differences in behavior between the two classes was mediated through her views of racial difference.

Kerry described behavior as a real problem in her Algebra I class. She described the class as being volatile and extremely disruptive at times. By the time of the study, Kerry had already had two male students dismissed from the class, and there was a third that she was hoping would soon drop out of the class given his excessive absences and tardiness. Kerry was relieved to see these students leave because of the way that they disrupted the class and her teaching. Although I am not sure of the race of the two students who were taken out of the class for disruptive behavior, the third one was Black. During my study, I observed Kerry taking students out into the hallway during class because of behavior issues. All of these students were Black and both male and female.

From the perspective that Black students might have been seen as more of a behavioral problem because of her misinterpretation of their behavior, Kerry's claims of the disruptiveness and volatile nature of her Algebra I class might be connected to her views of the students as opposed to their nature. Both classes had some amount of disruptive behavior. Below is Kerry's description of an event in the Advanced Algebra and Trigonometry class:

> In my Algebra and Trig class, the people that are achieving the least are my White, middle-class young men. They don't want to learn they don't want to do. One of them said, "Why are you calling me out?" when I woke him up the other day. I'm thinking, "You've got to be kidding." And I've had conferences with all of their parents. They're the ones that I have to talk to all of the time: really smart guys, but they are just really into something else right now….They think as I've heard often—their senior year is supposed to be fun [laughing], and I'm going, "No, it's supposed to be preparation for college."

The student who was sleeping during class, belligerent when reprimanded, was regarded fondly here by Kerry. Once Kerry reveals that the worst students in that class are the White middle class boys, a different racially marked image is painted with respect to the differences in the two classes. The Algebra I class with mainly Black students can become volatile, and the worst students in the class have been removed because of behavior issues. But the incident described above was not seen as problematic. Kerry did not regard the student as likely to become disruptive as in the Algebra I class. Kerry is likely caught up in a framework with the following components:

1. Black students are more likely to be regarded as disruptive and labeled behavioral problems (Townsend, 2000).
2. Black students are more likely to show up in lower-tracked classes and less likely to be in higher-tracked classes (Oakes, 2005).

Thus, the behavioral problems in the two classes become qualitatively different because the Black students in the lower track classes are seen as more disruptive. The consequences for learning are different, too. The students in the Algebra I class were more likely to get out of control once upset so that they were taken outside until they were calm enough to be productive members of the classroom or they were removed from the classroom altogether in effort to help the rest of the students. Removing these students from the classroom denied them the opportunity to learn mathematics, thus ensuring their continued placement in lower-track classes. On the other hand, Kerry regarded the behavior issues that occurred in the Advanced Algebra and Trigonometry class as less harmful and something that a quick phone call home would solve.

Kerry’s perception of her Algebra I students as plagued by behavior problems could possibly contribute to her claims of not being able to connect with her students and their regarding her in a strictly punitive role, which we have seen can be detrimental for student learning. Oakes (1985) reported a difference between the classroom climates in lower-track classrooms and higher-track classrooms. She found that the teachers and students in lower-track classrooms reported student-peer relationships as hostile and teacher-student relationships as mainly punitive. My data suggest similar phenomena.

Kerry's concern about her relationship with her students stands out because she was the only one who expressed such a concern, and she expressed it frequently. Kerry described a phenomenon that Oakes (1985) talked about as having to do with classroom climate. Neither Peter nor Amanda, who were teaching advanced mathematics classes, reported a lack of rapport with students in the way that Kerry did. Kerry described her interactions with her Algebra I students as possibly "volatile" and said that the students viewed her as a disciplinarian while her Advanced Algebra and Trigonometry students saw her as more of an ally. Further, she hypothesized that the Algebra I students were less likely to share their work for fear of looking bad in front of others. Kerry saw the creating of a comfortable classroom environment, one based on trust, as crucial to her students' learning. She said that this lack of trust—that they would not be laughed at—and their lack of confidence in themselves kept her Algebra I students stifled. Because of the lack of confidence and trust, she would often refrain from giving them mathematical activities that would cause them to struggle.

Oakes (1985) defined classroom environment in terms of the relationships between the different participants in the classroom – student-peer relationships, the relationship of the teacher with the students, and the relationship of the students with the learning experience. Given that the students in Peter's and Amanda's classes were similar to each other in age and grade-level, it is not surprising that neither would report much of a difference between their relationships with the students or their students' relationships with each other. Although both reported that the students in the lower track were more likely to get off task, neither participant suggested that one class caused more problems than the other with respect to camaraderie with each other or congeniality towards them as the teacher. Peter described his relationship in both classes with his students as one based on humor and sarcasm. He suggested that the students were used to his making fun of them and that he was used to reciprocal action in both classes. Amanda suggested that her relationship was based on her high expectations of all of her students. Being a White teacher from the midwest in an inner city school in the South, Amanda said that it was important that her students know that she wanted to be there working with them. Her relationship with her students was based on mutual respect and respect for their different cultures. Amanda confided that she loved working with her students, and though she was known to be a strict teacher who made her students work hard, she knew that they knew that she believed that they could be successful.

On the contrary, Kerry, who was teaching a lower level required course, Algebra I, struggled greatly with cultivating an amiable relationship with her lower-track students though she had one with her Advanced Algebra and Trigonometry students. In the interviews, a problem that Kerry kept coming back to was her inability to connect with her Algebra I class. Earlier I described how she reported the tendency for her Algebra I class to be volatile and to regard her as the enemy. Some students in the class would not talk to her. She talked about her students not being able to get along with each other as well, suggesting that the simple act of having students report out loud their solutions to a problem could incite a riot. In particular, she cited their tendency, given the opportunity to share answers as a whole class, to yell answers out. Kerry described how the yelling of answers out to the entire class, she described, would cause a chaotic scene ending with the Algebra I students screaming at each other and calling each other inappropriate names. Kerry's relationship with the Advanced Algebra and Trigonometry class was very different. She described the relationship as being friendly, sometimes too much so. The students would want to talk to her about other topics outside of mathematics and she would have to refocus attention. In my observations of her teaching, I observed Kerry having conversations with her Advanced Algebra and Trigonometry class about her own children and personal life. Several times, she talked to the students about what they needed to do to get financial assistance for college, citing her son, a student at the local university as an example. Kerry seemed comfortable enough to engage in such personal conversations with the more advanced group, but not with the Algebra I class. Further, she did not worry about peer interaction between the students in Advanced Algebra and Trigonometry. Overall, she described them as being able to work together and able to learn from each other.

This distinction in teacher-student and peer relationships mirrors the findings of Oakes's (1985) study. In her study, the teachers of higher-track classes reported amicable rapport between themselves and the students, while the lower-track students described their teachers as mostly disciplinarians. These relationships between teachers and their students are crucial to creating a productive learning environment and have been found to have an important impact on students' mathematics and science achievement (Wubbels, 1993). Students who reported having teachers who they deemed supportive and caring showed greater achievement in mathematics (Gregory & Weinstein, 2004). Thus, given Kerry's claim that her Algebra I students regarded her as the enemy as opposed to an aide; the tumultuous relationship could be detrimental to her students' success.

One consequence of the troubling relationship between Kerry and her Algebra I students was the permission granted to the students to be uninvolved in the act of learning. Two male students, both repeating the class for the second time, were kicked out of the class. Kerry also described another situation where a student was unwilling to participate, and she allowed the action to take place.

> There was a young lady in the back in the Algebra I class who had her head down. I did speak to her once about getting her head up. She was in the far corner over by the window. I did speak to her once, but I'm not going to. I've spoken to her and spoken to her and spoken to her. By now I'm going to spend most of my time on those who are trying to be involved. This is her third time trying that, which is not why I only spoke to her once. But she's not showing me anything that I can be helpful with, and so I am going to spend time on folks who are going to have questions and are trying to learn.

These students who do not see Kerry as an ally are more likely to be dismissed from class as they choose to not be involved in the act of learning. On the other hand, recall the situation where a student in her Advanced Algebra and Trigonometry class was asleep during class. Kerry told him to wake up. His response was combative. Her response to this incident was to hold parent conferences indicating that the students' decision to not participate in the Advanced Algebra and Trigonometry class would not be tolerated. These examples provide an interesting insight into how relationships with students have a possible impact on student success. In this case, the students in Algebra I who were dismissed from the class altogether or those that were left to not participate could not be expected to learn.

There could be a multitude of reasons for Kerry's inability to connect with her Algebra I students in a meaningful way. It could be that the more Black students in the Algebra I class affected the way that Kerry viewed her relationships in that classroom.

Although I do feel that the race of the students is crucial to this study, I do not think that Kerry's lack of connection between her Algebra I students was simply the result of disconnect between Kerry, a White teacher, and her Black students. To say so would imply that she could not relate to the Black students in her Advanced Algebra and Trigonometry class, which she never complained of. Even further, I am careful because comparisons between Kerry and Amanda and Peter would suggest that the latter, who did not have complaints about these same issues but were also teaching in racially diverse schools, were somehow better able to connect to the racially different students in their classes. Realistically, Amanda and Peter were teaching the older and still college bound students whether in the honors class or the regular class. Both Amanda and Peter described certain social ills that affected their schools. For example, Amanda, who taught in inner city Atlanta, described gang activity a as problem. However, the students typically involved in gangs, she said, had dropped out of school before getting to the advanced mathematics classes. Similarly, the poorer Hispanic students, who peppered the affluent student body at Peter's school were noticeably absent from the two calculus classes that I observed. Peter and Amanda were only teaching only advanced mathematics courses, and there was a certain homogeneity to their student population. They were all college-bound upper classmen, and fairly resilient. Kerry's students were not homogenous across classes. The consequence was an inability to form a teacher-student relationship focused on trust and respect. Kerry's Algebra I students would continue to be the lower students in the school because they were less willing to be involved in school and Kerry more reluctant to include them.

Research Question 2

How does knowledge of their students influence teachers' teaching practice?

This section draws on my interview and observation data. To organize the results of this research question, I use the major differences that Oakes (1985) found between lower- and higher-tracked classes.

As a reminder, Oakes (1985) who used data collected from high-, low-, and average-track classrooms, found differences with respect to content related knowledge and *learning beyond content*[2]. Knowledge that the students were expected to learn was more than mere content knowledge, but also processes associated with engaging in study of the subject.

> In analyzing all these data we looked for similarities and differences in the content of what students were expected to learn in classes at various track levels. We looked both at the substance of what they were exposed to and at the intellectual processes they were expected to use. (p. 74)

Content knowledge refers to the mathematics that the students of my participants were learning and the ways of *doing* mathematics that the students used during class. *Learning beyond content* is the phrase used by Oakes (1985) to describe those lessons provided by teachers that had to do with citizenship, scholarship, and behavior. This knowledge transcended mathematics and had more to do with the messages that the teachers were sending to the students about life without regard for a particular subject.

Knowledge

Oakes (1985) found differences in the content knowledge students in the different tracked classrooms were expected to learn. She found that the higher the level of student the more college-oriented the content. However, these differences in knowledge to be learned were reported only between higher-track and lower-track classes. The middle-track classes were described as being more like the higher-track than the lower. More specifically, middle-track classes were called a "diluted version" (p. 77) of the higher-track classes with similar goals

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[2] Time spent on instruction and teacher effectiveness including teacher excitement for the subject and tendency to criticize students are measured better quantitatively. As my study did not incorporate a quantitative component, I did not incorporate these components of classrooms into my data analysis.

towards knowledge expected and learning process intended. Oakes described the average-track classes in far less detail than the other two, but she said of the English class in particular,

> The teachers of classes intended for "average" students gave us information indicating that the learnings encountered in their classes were somewhere between the high- and low-track extremes. But it is worth noting that the kinds of knowledge and intellectual skills emphasized in those average English classes were far more like those in the high track than in the low. It is more appropriate to consider these classes as watered-down versions of high-track classes than as a mixture of the other two levels. (p. 77)

Specific to mathematics, Oakes found that while the content differed greatly, the "intellectual processes" were similar for all the tracks.

> Students at all levels of math classes were expected to perform about the same kinds of intellectual processes. That is, at all levels, a great deal of memorizing was expected, as was a basic comprehension of facts, concepts, and procedures. Students at all levels were also expected to apply their learnings to new situations. (p. 78)

Today, we expect that students should be to engaged in more reasoning, problem solving, and communication (NCTM, 2000) as well as to demonstrate conceptual understanding and procedural fluency (NRC, 2001). In my study, given the passing of three decades in which major changes to mathematics curriculum took place, I expected the process of *doing* mathematics to look different.

As I described in Chapter 2, Oakes (1985) made three claims about the differences in different tracked secondary classrooms with respect to content and intellectual processes: (1) the content differed between the high- and low-track classes, with high-track students doing mathematics deemed necessary for a college-career and low-track students doing mathematics centered on real-world applications like balancing a checkbook or basic facts; (2) the high-track and middle-track mathematics classes were similar in both content and processes; and (3) all three tracks of classes called on students to do similar processes.

Differences in learning beyond content were described by Oakes (1985) to include those lessons teachers sought to teach students that were not strictly related to content. The lessons might include teaching students about proper attitude and behavior for schooling and for productive citizenship. Oakes's data suggested that teachers' lessons for students in low- versus high-track classes differed, with low-track students being encouraged towards *conformity*. That is, they were being taught how to get along in class, to follow rules, or to improve study habits. On the other hand, high-track students were led towards autonomous thinking including critical analysis, communicating their own thoughts, and independence. Below I discuss how my data fit in with Oakes' claims by discussing a comparison of a lesson in the two classes each teacher taught, with respect to content, intended learned processes, and lessons learned beyond content.

Amanda. Comparing Amanda's two classes—the regular Advanced Algebra and Trigonometry and the Honors Pre-calculus class—proved to be the easiest of the three pairs of classes to compare. The two classes covered much of the same material but at different rates. The content was the same for the two classes with a few exceptions. For example, Amanda spent more time reviewing concepts from previous classes such as Algebra I, Algebra II, and Geometry with her regular class. She did not provide the same review for the honors students. There were some topics that she covered in the honors class that were not covered in the regular class. For example, in discussing properties of sinusoidal functions, Amanda talked about continuity and boundedness with the honors class but did not do so with the regular class. Given that the honors students would be going on to AP Calculus, where such concepts would be explored in more detail, it made sense that Amanda would cover such topics with one class and not the other.

There were some differences with respect to the intellectual processes encouraged in the two classes as well. Amanda did promote learning involving discourse and discovery, but there were several instances in which the honors students were either expected to engage in intellectual processes not expected of the regular class or they were pushed to engage in the processes more rigorously than the regular students. For example, the honors class was given several assignments that the regular class was not given. One was a research project on the history of mathematics. Amanda's decision to assign this project to the honors students and not the regular students was based on the requirements for honors classes in the school district. As mandated by the school district, the students were required to complete a research project by the end of the year in each honors class. The students in the regular class were exposed to the content—the history of mathematics—but through a different medium. Instead of conducting research projects, Amanda would tell the students about the historical contexts of a mathematical topic as it emerged during class.

> J: Will you incorporate any sort of the history of --
>
> AL: As we [in the regular class] come across things, I tell them about the history of things, and we talk about why we came up with it and, you know, where it came from, and that kind of thing. But I don't require them to go do the research.

Amanda said that the content—the history of mathematics—was provided in both classes, but this example suggests differences in processes that students were exposed to in each class. Although the assignment was somewhat out of her control given the district requirement for an honors class, the honors students actively engaged in searching for answers via research, whereas the regular students passively took in the history provided by Amanda.

I observed a second example when Amanda gave different homework assignments to the two classes. The honors students were given a homework assignment where they had to take several mathematical statements and give a justification for why the statements were true. This homework assignment was not given to the regular class. Amanda justified its significance for the honors students because these students would be called on to do similar assignments in Honors Calculus. In addition, her decision to not provide the same assignment for the regular class was based on her fear that such an assignment would be too open-ended for them.

> They were true statements; there were no questions with them, and what I asked [the honors students] to do was go through and explain why each of them was true. I want them getting more of the why things work and being able to explain that better—because they're getting ready for the AP Calculus class, and they're going to have to explain that on the AP test. Whereas the Advanced Algebra and Trigonometry kids, an assignment like that would just blow them away. They wouldn't even know where to begin with that. So I ask the why questions; I just don't do it in the same format. I'll ask them as we're going through class.

Amanda thought that it was crucial that the honors students develop communication skills. She wanted them to strengthen their ability to defend and discuss their reasoning and justification. The regular students worked on such skills but not to the extent that the honors students did. Amanda might ask a student why or how he or she got a particular answer in a whole group discussion, but the honors students were required to formally communicate why an answer was so or the process they used to solve a problem.

Amanda provided different mathematical tasks for the two classes, but this she said was rare. My observations supported this. Usually she gave each class the same assignment adjusted a bit for the different goals and level of understanding in the two classes. The different ways in which she facilitated the same activity in the two classes brought to light where the real differences in teaching resided.

During the several weeks that I conducted observations of her teaching, I was able to see Amanda teach one topic to one class and then several days later teach the same topic to the other class. Although the content was basically the same for the two lessons, I found that some of the processes that were stressed and the *learning beyond content* implied in the teaching of the lesson differed.

One of the lessons that I observed dealt with applying transformations of functions, a concept developed earlier in the semester, to a new class of functions—trigonometric functions. The students, familiar with the graphs of the functions $f(x) = \sin x$ and $f(x) = \cos x$ were given a worksheet with directions to graph different transformations of the two parent functions. Based on their exploration with the graphing calculator, they were to generalize about which coefficients in the equation enacted represented transformations of the parent function. In both classes, the activity spanned two 30-minute periods over 2 days. Students in both classes were provided the same activity and were expected to learn the same content—the application of the concept of transformations of algebraic functions to trigonometric functions. The processes that students were supposed to use included exploring different graphs, looking for patterns among the graphs of the transformations, and making generalizations about the functional representation of a trigonometric transformation and the graph. Using the same activity might have been Amanda's effort to expose all of her students to the same rigorous content and involve them in the same mathematical processes; however, during my observations of the classes, I found major differences between how the lessons played out in both classes, which in turn created differences in the actual mathematical learning opportunities that were provided for the two different groups of students.

Amanda's scaffolding of the lesson was different in the two classes. In the introduction to the lesson presented to the honors class, the class finished a discussion about the graph of the function $f(x) = \sin x$ including its properties as continuous, bounded, and periodic. After passing out an activity sheet to the students, Amanda's only instruction was a reminder to put their graphing calculator in radian mode and to work with only one partner.

> AL: I want to look some more at trig functions, but I want **you** to look at trig functions first. So for the rest of the class period, we're going to analyze some trig functions…. You may move to work with somebody else if you want to. Okay, I'm going to be coming around to collect some items from you while you are working.

The students moved to their new seats to work with a partner. Amanda began to walk around to talk to each student about his or her topic for the required research project. After the students had been working for about 10 minutes, Amanda stopped them to point out that they should recognize that they were applying the idea of transformations of functions to trigonometric functions.

> AL: So what are we looking at as you look at different functions? What's the big topic of what we are applying to trig functions right now?
>
> Student: What do you mean? The bigger picture?
>
> AL: Uh huh. We've done some of these things with functions before. Keep thinking on that as you move through the questions. Think about where you have seen some of these

types of things before when we studied functions. Because it’s going to relate back to something else that we’ve done already.

Amanda goes back to walking around the room and asking each student about his or her research topic.

Amanda provided students little instruction before actually letting them begin the exploration. It was after several minutes of their working, without giving them the answer, that Amanda pushed them to think about connections between trigonometric functions and other functions that they had explored in class. In the regular class, Amanda provided much more direction to the students, including making the connections between the activity and transformations of polynomial functions before they even began the activity.

In the regular class, the graphing activity followed the students’ graphing of the two trigonometric functions $f(x) = \sin x$ and $f(x) = \cos x$ by hand using table values. Amanda introduced the graphing activity as follows:

AL: Now what we are going to do is we’re going to start exploring a little bit more about how these functions behave. Now before we do that, I want you to review. Remember back in chapter 3 where we talked about transformations of functions? And if you remember, we had *A* times a function, and we could have a *b* inside minus *c* plus a *d*. Y’all remember that?

Students: No!

AL: Oh yes you do. Let me write it like this. How about if I made it a quadratic function?

Student: I remember this.

AL: If I have a number outside multiplied by – Oh I'm getting some of it. It either dilates it or translates it. Do y'all remember that? And the things inside the function were horizontal or left to right.

Students: Oh, yeah!

AL: Now it's looking familiar. Left and right and outside was vertical or up and down, and multiplying did what?

Student: Reflect.

AL: It could reflect. What else could it do?

Student: Bigger or smaller

AL: Bigger or smaller. Remember the marshmallow example. We squeeze the marshmallow one way. If we make it smaller one way, it gets taller the other way. How about adding? What did adding do? That's a translation.

Student: You mean on the outside?

AL: It doesn't matter. If it's inside it translates it left and right; if it's outside it translates up and down. Is that looking familiar from chapter 3?

Students: Yes.

AL: Okay, good. We're going to take that idea and see how it works with trigonometric functions. 'Cause the same thing that works with other functions should work with trig functions. So, here's what's going to happen—I have this calculator activity that I want you to do. You may work with a partner….What we are looking at is how we can transform trigonometric functions.

Amanda provided a much more detailed introduction in the regular class. She reviewed the key concepts of transformations of functions. Amanda told the students to get their worksheet out in front of them and then went through the first two questions with the entire class. In the first two questions, the students were to determine the appropriate window on their calculator. Amanda walked them through finding the minimum values for x and y as well as the scale. This direction was different from that with the honors class, who were left to find the window on their own. In that class, the only guidance Amanda gave was a reminder about putting the calculator into radians.

There is a difference between the amounts of scaffolding supplied by Amanda to the two classes. In the honors class, the students had been working for several minutes before she even mentioned the connections between what they were doing and what they had done with transformations of functions. In the regular class, she provided a review of what the class had learned about transformations from their lesson on transformations of functions done earlier in the year. She reminded them of the relationship between coefficients in the equations and the transformation of the graph of the parent function. She also provided much more structure in terms of using the graphing calculator, as well. The first question of the worksheet instructed the students to change the window. Although this merited a small reminder in the honors class, Amanda illustrated the changing of the window for the regular class and then checked to make sure that everyone had followed her directions. It was only after that point that the students began to work in their groups on the activity. In general, the honors students received much less direct instruction than the regular students. In particular, they were left to make the connections between transformations of general functions and transformations of trigonometric functions on their own. The honors students were expected to recall and incorporate previous knowledge to a new task. They were expected to see that the transformation coefficients caused a similar transformation for sine and cosine as it had for the transformation of a polynomial function. In the regular class, Amanda made these connections for the students before they began to work.

During the group-work portion of the activity, Amanda was active in the same way in both classes. She walked around, answered students' questions when they were directed towards her, managed their time by telling them how much time they had to finish the assignment, and interjected comments on the activity to the whole class periodically. When students in either class begin to form an idea about a generalization of what they were seeing, Amanda reacted in the same way, by pushing them to think further about what they were seeing.

It was not until the end of the lesson, after Amanda had instructed the students to turn in the activity, that I saw another difference, this time in her approach to summing up the lesson. Below is the conclusion of the activity in the honors class. In a whole-group activity, the students turned their desks to the front of the room, and Amanda led the discussion. On the overhead Amanda wrote:

$$y = A\sin(b(x-c)) + d$$

> AL: Okay, this looks very familiar to me because we've studied transformations on parent functions in other chapters, haven't we? And what we learned is that when something is what we say inside the function, it affects the function in the horizontal direction, right? And when something is outside of the function, it affects it in the vertical direction. The things that are outside of the function are the *A* and the *d*. And the things that are inside the function are the *b* and the *c*. And when we've added something or subtracted something on—it's either going to shift it left or right or up or down. So things that are translating are the *c* and the *d*. And when we multiply that gives us *a*?

Amanda paused when students don't answer.

AL: What does multiplying do?

Several students answer that it was a dilation.

AL: That gives us a dilation. This one is the vertical one, and this one is the horizontal one. And with other functions we said it's kind of like if you squeeze it horizontally, it's going to stretch vertically. Did that happen necessarily with these?

Several students answer that it was different.

AL: They behave a little bit differently, don't they? So just because you squeeze it one direction, it's not necessarily going to change it in the other direction as other functions did. Now in trigonometry we give these some different names: *b*, before we would have called it a horizontal dilation. What did it change on your functions in this case?

Student: It changed how close they were—the frequency.

AL: It had something to do with frequency. Like how many times it repeats. In your reading tonight you're going to figure out what frequency is all about because you have heard frequency a lot haven't you? But yesterday we talked about the period of the function. Didn't this effect what the period of the function was? Like now it takes from 0 to 2 pi before it starts repeating. But if you change this, it might repeat more often, or it might repeat less often. So this affects the period, and you are going to learn about how period relates to frequency.

Amanda goes through the rest of the variables and gives them their trigonometric name. At the end of the discussion, she has written the following chart on the board:

|A| → "vertical dilation" → Amplitude

b → "horizontal dilation" → changes period

c→ "horizontal translation" → phase shift d→ “vertical translation”

She reminds students about the complexity in combining the phase shift and the horizontal dilation. She tells them to think about that. The total discussion takes less than 5 minutes. At the end, Amanda gives the students a reading assignment from the textbook on the meaning of the coefficients for transformations of sinusoidal functions.

In the regular class, the summary discussion is more detailed. Amanda stops the activity short once she realizes that the students are not progressing to making generalizations. She also notices that they have gotten off task and are not actively doing the activity. After the students turn in the activity sheet, Amanda instructs them to turn their attention to the front of the classroom. On the board, she draws the graph of a transformation of $f(x) = \sin(x)$. The graph is of the equation, $f(x) = 3\sin 4(x)$. While students are arranging their desks for whole-group discussion, Amanda instructs them to look at the graph.

AL: There is a function on the board I want you to think about. From the things that you saw in this activity, how could you figure out what the equation of this function is? And I will tell you that the window is the same as the window that we were working on. How can you relate what we just did to this function? So what do you notice about this function? Any ideas?

Student: It’s repeating.

AL: It’s repeating. Okay. Is it repeating more than it did on your standard function? Or less.

Students: More.

AL: How could we decide if it were a sine function or a cosine function?

Students say something about looking at whether or not the graph goes through the origin.

AL: Oh, one of them starts at the origin, and the other one doesn't. So which one is it?

Students: Sine.

AL: Sine because it does go through the origin. Okay. So—So far we've decided that this is *y*, and there's something with a sine in it. What do you think I've changed?

Amanda writes $y =\ \ \sin\ \ x$ on the board. She leaves room for the coefficients in front of the sin and the *x*.

Student: *A*.

AL: The *A*. Why do you think I've changed *A*?

Student: Because it repeats more often.

AL: Because it's repeating more often? Do y'all agree? Is *A* what makes it repeat more often?

Student: And *k*.

AL: Well, it was *k* or *b*. Okay. There was a number out in front of the whole function and then there was a number in front of the angle. One of them made it repeat more often and one of them did something else. Which one made it repeat more often—the one all the way out in the front or the one in front of the angle?

Students say different things.

AL: The one all the way out in front?

Students: Yeah.

AL: Kendria is saying that it's the one in front of the angle. Okay? What did we say over here? If it's inside the function it affects what it looks like left to right. Correct?

Student: No! It’s the one on the inside.

AL: It’s the one on the inside because what we are really doing is taking our function and squeezing it in. So I know need to put something different in here [motioning to the space in front of the *x*]. Do I need to put something out in front?

Ray: Yes.

Student: No.

AL: Why, Ray?

Ray: Because, uh, I don’t know why, but I know you need to put something out front.

AL: What does this number out here affect?

Ray: It affects the altitude.

AL: Tell me—.

Ray: It affects the hills.

AL: What about the hills?

Ray: It shows you how many—hold on, let me think.

AL: Does it show you how many? Or Rashelle, what’s your thought on it?

Rashelle: How far it goes up.

AL: How far it goes up. This number out here shows you how high it’s going to get [motions to the *A*], and this number right here [motions to the *b*] tells you how many you are going to get. Does that make sense?

Students: Yes.

AL: So let’s stick with this one here for a second [motions to the A]. How high does this get?

Student: Five.

AL: Huh?

Student: Three.

Al: Well, this was the same window. What was your window on that function? It went from –4 to 4. So how high does this go?

Student: Four.

AL: Nope. Four would be all the way at the top.

Student: Oh, three.

AL: Three. So there's a three out in front here. Okay. Now, normally a function it takes it from 0 all the way out to 2 pi before it repeats. How long does it take this one to repeat? [Silence.] It starts repeating here right? [Points on the graph.] So there's one section. Here's another section. Here's another one. So there are four of them over here, aren't there [points from 0 out to 2pi], and there are four of them back here, right? [Points from 0 to – 2 pi.] So what number do we need to put in front of the *x* to get…?

Student: *4x*.

AL: Okay, try that on your calculator and see if it works.

Students check on their calculator that the graph of the equation that they have just determined looks like the one drawn on the board.

AL: Is that it? Does that work?

Student: Yep.

Amanda then begins a discussion of how to figure out the period of the transformation once *b* is known. She asks the students for the connection between *b,* which they now understand to be the number of times the graph repeats from 0 to 2 pi, and the period. She then gives them a formula for finding the period once *b* is known. After this discussion Amanda begins the same generalization discussion that she had with the honors students.

AL: What we've been looking at are these transformations of the trigonometric functions. And I've chosen to put sine in there, but I could have put cosine in there because the letters all have the same effect. Okay I see people with no paper on their desks and hands hidden. You need to be ready to write. We're taking notes and this going to take us about five minutes and then we're moving on…Okay what did we decide *A* effects? What does it do?

Student: umm are you talking about like dilation and stuff?

AL: That is what I'm talking about. It is a--

Student: Dilation.

AL: Dilation. What about when it is negative?

Students are silent.

AL: If I multiply by a negative to this what would it do?

Student: It would flip it.

AL: It would flip it so it would start out going down. And what would we call that?

Student: Reflection.

AL: Reflection. So the type that you get with letter *A* is a dilation, or and it could, and – a reflection. And the reflection is if *A* is negative. Okay? So *A* always creates a dilation or a reflection. And it's outside, so it's going to be a dilation in the vertical direction. Now when we're talking about other functions, we just kept calling it a dilation. But now, when we're talking about a sinusoidal function, we can actually give it another name. And we call that the *amplitude*. So now we're calling it the amplitude. Now the one thing that you have to remember about amplitude is not the height from the very top to the very bottom. Okay? It's the height from what we call the midline to the top or the midline to the bottom.

Student: Like in science?

AL: Just like in science. I call that the *equilibrium point* or the *equilibrium level*. And so for other information I want you to write down that it is the height from the midline to the top. And we always look at as a positive value. So if there is a negative four out in front, I would still say my amplitude is four because the negative did the reflection.

Amanda goes through the rest of the coefficients asking the students what they thought each coefficient did based on what they had just done in the activity and the last problem. She then gives them the correct term for the transformation when talking about trigonometric functions. At the end of the discussion, Amanda has written a similar chart to the one drawn on the board at the end of the summary discussion in the honors class.

The summary discussions for the two classes differed in multiple ways. For one, the honors class was given a reading assignment for that night that would fill in some of the gaps about the transformation coefficients not covered in the class discussion. For example, the reading assignment covered the relationship between the coefficient *b* and the period of the graph. Although the regular students' summary discussion had included a discussion about this relationship, ending with Amanda describing the algorithm for finding the period once *b* is known, the honors students were to find this out for themselves from the reading and were called on to apply this new knowledge during the following class meeting. Second, the whole-class activity of finding the equation of the graph of the transformation of $f(x) = \sin x$ did not happen in the honors class in the same way. The honors students came in to class the following day, after doing the reading on transformations, and were given the instruction to find the equations of two graphs drawn on the board. Amanda's only instruction was that they were to draw on what they had learned from the graphing activity and from their reading. After students worked for about 10 minutes, Amanda called the class together and called on student volunteers to offer their equation and discuss their thinking. Amanda facilitated the discussion of student thinking by asking specific questions of the students who were sharing their answers. For example, she asked, "How did you decide that the graph was of a sine or cosine function?"

In an interview conducted after the graphing activity lesson in the Advanced Algebra and Trig, Amanda described why she provided more structure for the that class versus the honors class.

> AL: Now what you saw in my fourth block is that they were sitting there doing all sorts of other things. And it didn't matter how much I walked around, they were doing whatever they wanted to. And they weren't getting it done. And then some of them were just sitting there; they weren't discussing at all. So rather than let them sit there and do that for the entire [period] and still not get it done – that's when I said, "Forget it. We're done with this." Um—I think it gave them enough to see some different functions and see what the numbers might do, but they didn't get it nearly as well as my other two classes did using that. Which I expected that because I know the level of that class is lower than both of my other classes.

The topics covered in the two lessons were identical. The students were expected to understand the relationship between transformations of general functions and transformations of trigonometric functions. They were to use an exploratory exercise to see patterns and generalize that certain coefficients, as with general functions, cause certain transformations. Finally, they were to be able to apply this knowledge to the activity of determining the function notation for a given transformation given the graph of the transformation. The processes were the same, with both classes using exploration, making generalizations, and applying concepts to unfamiliar problems. Even communication and justification were evident in both classes as Amanda asked students in both classes to describe their reasoning. Clearly, though there were some differences between the way the two lessons played out. These differences were in the lessons learned beyond those dealing explicitly with mathematics content. Oakes' (1985) distinguished between a lesson of independence for higher-track students and a lesson of conventionality for lower-track students. I cannot apply these terms in the exact way that Oakes defined them, for several reasons. For one, Oakes claimed that the middle-track classes were more like the high-track classes with respect to lessons outside of content. Secondly, the lesson of *conformity* for the lower-track classes was much more extreme than any thing my data would suggest. Oakes described the lessons for the lower-track class as including self-discipline, hygiene, respect for authority, and responsibility. On the other hand, the lesson of independence for the high-track students included students applying gathered information, interpreting and analyzing tasks, reliability on own thinking, and confidence in their own thoughts. In the lesson in the honors class, Amanda pushed her students to be independent thinkers. She encouraged them to find the connections between their previous knowledge and this new task. She limited the amount of direction she gave before and during the lesson. Amanda gave the students a reading assignment that further summarized the concepts of period and amplitude, new concepts to the students. Without even discussing the reading, the students were expected in the following class meeting to draw both on their reading and what they had learned from the transformation activity to apply it to a new task—finding the functional notation for the graph of a transformation. Without giving them any hints other than to use what they'd learned, Amanda sent the students off in pairs to tackle the activity.

The extreme described by Oakes for the low-track class by no means fits with Amanda's approach to teaching her regular students. However, to say that the regular class had lessons similar to the honors class glosses over a qualitative difference between the ways that Amanda approached the teaching of the same activity to two different classes. My observation and interview data offer an opportunity to look in depth at how the lessons outside of content differed for these two classes. The push for independence in the honors class far surpassed any attempt in the regular class. For example, absent from the regular class was the opportunity provided to the honors class for discovering on their own the familiarity between the graphing activity and previous knowledge about transformations of general functions. Amanda not only provided the connection, but also reminded them of the specifics – that is, which coefficients affected which transformations. Amanda in essence gave the regular class the answers before they even began the activity. Further, in walking them through the first two questions of the assignment, Amanda took away the intellectual activity of figuring out the appropriate window on the calculator for the rest of the exploration—a task that was provided for the honors class. Finally, at the end of the discussion of the activity, Amanda did two things differently than she did with the honors class. For one, she structured the activity of notetaking for the regular students. She provided a frame for their notetaking so that as the class discussion went on, the students filled in the frame with the information important to the lesson.

> I gave them kind of a notes frame, and we filled in the notes frame together. I did that with my Advanced Algebra Trigs. I did not do that with my honors groups. So that was definitely – I try to help my Advanced Algebra Trig organize their notes a little bit more.

> Um, the honors Pre-Cal kids usually do a pretty good job taking notes. There are a few kids in there that need some help, and so I work with them, and I have them partner with somebody to get notes and things like that. But in the Advanced Algebra and Trigonometry, I do structure the notes a lot more.

In giving the students a frame for the notes, Amanda was providing some lessons about good scholarship. She was also, as Oakes' data suggested for the low-track classes, pushing her regular students to conform to the standards for good students—one who takes good notes during class.

The second difference in the summary portion of the lesson was the whole-class, teacher-led discussion of how to determine the functional notation of a graph of a transformation. Instead of letting the students draw on what they had learned from the activity and apply it to a new problem, Amanda decided instead to walk the class through, with student input, the solving of the problem. Again, this decision took away from the independence in thinking that was given to the honors class, who came in the following day to nothing more than two graphs on the board and instructions to use what they learned the previous day to find the equation of the graph. Based on this lesson, it appears as if the honors students were pushed to be more independent in their problem solving and thinking than the regular class. Amanda said that the honors students are pushed more to be independent thinkers:

> And it [the honors class] is very rigorous. I don't tell them a whole lot. I ask them a lot of questions, and I want them to figure it out. Um, I like to leave things just kind of hanging out there [laughs]. And they hate it, but they learn from it.

Teaching in this way, pushing the students to find out for themselves, characterized the pedagogy in the honors class. However, this independence in thinking was not seen in the regular class to the same extent. Amanda admitted this herself as she described for me in an interview before the graphing calculator lessons the differences that I would see.

> Yeah, and it's the same content. It's the content but it will be presented in different ways. And you'll see, with like with the honors Pre-Calc kids, I can give them a group activity—Like when they get this calculator activity today, I'll be able to come, sit, and I can hear what they're talking about, and I know what they're doing. And I'll walk around and see what they've got and give them a little bit of direction. The Advanced Algebra and Trigonometry when I give them something like that, it's almost like you've got to go around to them constantly. And sometimes I will make myself come over here and sit down, because if I go to the group, they want me to answer all the questions for them, and I don't want to answer the questions for them. The honors Pre-Calc is to the point where they won't even try to get me to answer the questions because they know I'm not going to tell them anything.

Amanda admitted that she had to make a conscious effort not to give the answers to the regular students, something that is automatic in the honors class.

Amanda expressed a desire to teach the regular class as a high-track mathematics class. Further, she wanted her students in both classes to be independent mathematical thinkers. Independence was not a lesson taught in both classes to the same extent as indicated by the differences in the graphing calculator activity, the difference in assignments provided for the two classes, and her reflections on the difference in her approaches to the two classes.

Much of the differentiation between pedagogy for the two classes arises out of Amanda's perception that the regular class, less motivated and driven, required more structure. Amanda though that the regular students were less likely to participate aggressively in activities that would call for a significant amount of open-ended time. For example, during one class period, the honors class divided into four groups—each group with a different task. One group was to create a large model of the sine curve, another the cosine curve, and the third, a giant unit circle with radians and degrees labeled clearly. The fourth group was to create a "word wall" where they decided on the important concepts from the unit and pasted the concept and its definition on the back wall. Although the activity seemed a worthwhile experience for the students, giving them a chance to use creativity, it was one she suggested would not be done in the regular class because of it's lack of structure.

> J: So would you do this with the regular class?
>
> AL: Oh no. No. It's way too unstructured for the regular class. They wouldn't come up with the graphs quickly for one thing. I would have to give them two class periods, which I just can't sacrifice two class periods to do something like that. And it was chaotic with the third-period group, but they were all – it was good chaos. They were all working except for my *word wall* group. They got a little off track. But they were all working on it and talking about the functions the whole time, which I thought was just so cool. But my regular class—they wouldn't be as focused on it. They need something that's much more structured. Chaos is a good thing and I let them have chaos in the classroom at times. But it's more structured than what I have to do for the honors.

The regular students' tendency to not stay on task plus the amount of time it might take them to do the activity either based on level of understanding or motivation prevented Amanda from having the regular students engage in the activity.

Amanda tended to provide more structured review activities for the regular students as well.

> I do more games and very structured review for the lower-level class. Then for the honors class, I let them tell me what they need extra help on. I leave it up to them very much. So a review for them will look like – you know. “Here are some suggested problems you tell me what you’ve got questions on.” I don’t build in nearly as much review for them – review time in class, as I do for the other level.

Holding review activities in the regular class ensured that they would actually study for the test. Making it more structured helped ensure that they would be on task and actively reviewing before the test.

> It’s structured, and it tells them exactly what they need to be doing. Gives them a limited time to look at one problem and then move on to something else. Because if you make it too open for the lower-level kids, they’ll – they just don’t know how to handle that.

Amanda thought that the regular students required structure in a way that the honors students did not. For one, whereas the honors students could be counted on to ask questions throughout the semester, even coming in after school to get further help, the regular kids could not. If Amanda did not give them the opportunity in class to review, they would probably not study; and if they did, they would be lost as to what to study. However, in providing structure for the regular students, again Amanda did not push the regular students to be responsible for their own studying or learning. Instead, in providing a structured review activity, she ensured that the students did not have to worry about studying outside of class for the test. They did not need to be responsible for deciphering what might be important information to know for the test.

These differences in approach to the two classes as well as what I observed in her teaching of the same lesson to the two different classes suggested that Amanda was making decisions to provide what she described as more structure to the regular students. Providing more structure took away some of the independence and responsibility of learning from the regular students. Thus, Oakes' (1985) idea that the middle-track classes were *watered-down* versions of the honors class might apply if by *watered-down* she meant that the students were given less responsibility for becoming independent mathematical thinkers than the students in the honors class. However, Amanda's choice to teach in this way is explicitly intertwined with her ideas about the students in the regular class. She held high expectations for the students in that she wanted all of her students to be mathematical thinkers. Amanda said of the two classes:

> I would love them to all to be at the same place. I mean I would really I want them to think mathematically about situations. I want them to be able to look at a situation and say, "Okay I can see this type of function working for that." Or you know, I want them to be able to analyze things mathematically.

However, the students in the regular class were less motivated and were less prepared mathematically for the advanced mathematics class. Thus, Amanda taught identical activities to both the honors students and regular students, but made accommodations for the regular students to ensure that they were both actively engaged, stayed on task, and made adequate progress throughout the course. In the end, it was their independence that suffered.

Peter. Peter's two Calculus classes offered an interesting comparison, as well. Because I was able to observe his back-to-back teaching of the regular and the AP Calculus classes, differences in instruction as well as learning opportunities provided to the students were clear. The topics covered in the two classes were mostly identical—first semester Calculus. However, like Amanda, Peter reported having to review topics with the regular class—particularly those he could not assume the students had learned or remembered from earlier classes. On the contrary, he took students background knowledge for granted in the AP class. Peter did not spen a great deal of time reviewing material from earlier classes in the AP class, and so, the AP class was consistently ahead of the regular class by at least a week. Finally, the external motivator for the AP class was the AP exam. The test looming, Peter described not being at all hesitant in making the AP class challenging.

> So all the time I am trying to push [AP Calculus students] beyond where they should be….I am not looking for a friendly environment at the beginning of the school year. I am looking for a challenging environment.

This description is in stark contrast to the type of environment that Peter tried to cultivate in his regular class. In that class, Peter tried to create a comfortable environment for the students who in their senior year did not need to be easily frustrated or frightened. Instead the students needed an overview of the material so that when they took calculus as freshmen in college, they would have seen most of the material at least once before. These contrasting goals along with what Peter saw as a difference with respect to both motivation and mathematical ability contributed to differences in content and in the intellectual processes that students were exposed to in the two classes. Like in Amanda's classes, there were differences with respect to lessons learned beyond the content in Peter's classes, as well.

Because Peter taught on an A/B Block schedule[3] and the regular class was always at least one week behind the AP class, I was never able to see Peter teach one lesson in the AP class and then teach it later in the regular class. I observed Peter's teaching of two different lessons—one on the binomial expansion theorem to the regular class and one on the chain rule in the AP class. The goal of the binomial expansion theorem lesson in the regular class was for students to work up to seeing a pattern in the expansion of $(a+b)^n$, learn the theorem, and then use it to expand

[3] A/B Block scheduling employs an alternating day schedule such that a class meets Monday, Wednesday, and Friday of one week and then meets Tuesday and Thursday of the next week. Therefore, in a two-week period, the class only meets five times.

binomials raised to an exponent. All of this was in preparation for using the chain rule in differentiation. While this lesson took an entire class period in the regular class, Peter reported that he spent little time on the topic in the AP class, as it was assumed that the AP students remembered learning this in an earlier class. I will delve into specifics of the lesson later, but in general the lesson began with Peter guiding the students through expansions of polynomials of the form $(a+b)^n$ by using expansions they already knew such as $(a+b)^2 = a^2 + 2ab + b^2$, the fact that any binomial of the form $(a+b)^n$ could be rewritten as $(a+b)^n = (a+b)^{n-1}(a+b)$, and the distributive property. The procedural tasks of expanding binomials raised to exponents provided the motivation for finding a quicker way to expand binomials. Peter, with input from the students, uncovered the pattern in Pascal's triangle and applied it to the expansion of several binomials. Peter further motivated the need for a more efficient way of expanding binomials and introduced the general form of the binomial expansion theorem. The lesson ended with students practicing with the theorem by applying it to different expansions. The content students learned included Pascal's triangle, the binomial expansion theorem, and how to apply the theorem to expand binomials. While the activity included using an inductive process to generate the general form for the expansion of $(a+b)^n$, there were several additional intellectual processes that characterized the students' engagement in the activity. While the regular students were engaged in some higher-order intellectual processes—finding patterns and describing their thinking, they were mostly engaged in intellectual processes that did not require much critical thinking, but instead spent the majority of their time doing more procedural activities.

Peter began the lesson with instructions for finding the binomial expansion for $(a+b)^3$. Peter instructed the students to expand $(a+b)^3$ by regarding it as the product of $(a+b)$ and $(a+b)^2$.

PN: I am going to start you off. I want you to distribute the *(a +b)*, and multiply, out and give me an answer which is already written out for you.

After checking that the students had correctly completed that task, Peter gave them a similar problem to do with the same instructions.

PN: I want you to use the same technique to do $(a+b)^4$. This will be *(a + b)* times $(a+b)^3$, which you've just got, so you can work through that in a similar way. Okay?

Though the final expansions for both binomials were written on the board, Peter had the students expand the binomial on their own using the procedure that he modeled. Peter demonstrated what to do, the students watched, and practiced on their own with two additional problems. The answers were written on the board ahead of time so that they could asses their answers.

Later in the lesson, the students were asked to recognize the pattern in Pascal's triangle. Peter wrote the expansion for the binomials they had already expanded on the board.

$$(a+b)^0 = 1$$
$$(a+b)^1 = 1a + 1b$$
$$(a+b)^2 = a^2 + 2ab + b^2$$
$$(a+b)^3 = 1a^3 + 3a^2b + 3ab^2 + 1b^3$$
$$(a+b)^4 = 1a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + 1b^4$$

He instructed the students to spot a pattern for the exponents and the coefficients of each the terms in the expansion.

PN: I want to stop for a moment and look at what we've been doing that's common here. As you go along, the powers of *b* are increasing and the powers of *a* are decreasing. Along came a gentleman—people knew how to multiply out for a long time, but a gentleman by the name of Pascal came along and said let me lay these results out. Pascal looked at that and said, "There's a bit of a pattern here." I am not going to tell you what

> the pattern is. What I would like you to do is look for the pattern…..If you know what it is—hold on for a minute. I would like you to look at the pattern and then see if you can write down for me *(a + b)* to the power of 5 without doing any multiplication.

This task required that the students notice the pattern and then use it to find the expansion of $(a+b)^5$.

As students worked on the task, Peter walked around to see their work. He suggested that the students write down their hypothesis for the pattern. After several minutes, Peter called the class' attention back to the front. He began to go over the problem with the class by calling on individual students to give one term of the expansion. Students were asked to clarify their rationale for their answer. Students were asked to communicate both their answers but also their reasoning behind their answer.

As Peter led the students towards the end goal—using the binomial expansion theorem—he focused the students' attention to making generalizations about the expansion of the binomial, $(a+b)^n$. These generalizations included that there were always n+1 terms in the expansions and each expansion began with a^n and ended with b^n. Finally, telling the students that abstracting the pattern was difficult, Peter developed the general form for the class by writing out the first few cases.

$$(a+b)^0 = 1$$

$$(a+b)^1 = 1a + \frac{n}{1}b$$

$$(a+b)^2 = 1a + \frac{n}{1}ab + \frac{n(n-1)}{1 \cdot 2}b^2 = a^2 + 2ab + b^2$$

While Peter was writing these on the board, the students took notes. At this point in the lesson, Peter lectured with no student input.

During the next portion of the class, the students used calculators to calculate factorials and ${}_nC_r$. Peter led them through this activity on the overhead projector with a graphing calculator and. After Peter demonstrated the calculations for the students on the calculator, he gave them some time to practice the skill. Once Peter thought that the students had mastered the skill, he called the students' attention back towards the front of the room, where he wrote the general form of the binomial expansion on the overhead projector.

$$(a+b)^n = \sum_{k=0}^{n} \binom{n}{k} x^{n-k} y^k .$$

Then Peter demonstrated how to use the general form and the class ended with the students applying the formula in several practice problems.

The regular students spent the majority of class time watching Peter demonstrate procedures, practicing procedures on their own, and taking notes. While I observed several points during the class were the students could have discovered mathematics themselves—coming up with the pattern in Pascal's triangle, applying it to a new problem, and discussing their thinking, in general, the students did not do much higher-level. The higher-level thinking such as taking the pattern and abstracting it to the level of a general form was done by Peter and the students followed along. The students were led through much of the lesson with little time to do individual work. When they did engage in individual work, they applied a procedure demonstrated by Peter. Otherwise they were observing Peter and taking notes.

The day following my observation of the regular lesson on the binomial expansion theorem, I observed Peter teaching a lesson on the *Chain Rule* for derivatives in the AP class. The students used the TI-89 graphing calculator (it has capabilities of factoring and finding derivatives) to do several examples of finding derivatives for binomials. From there they looked for a pattern to develop a general rule for differentiating any binomial of the form $(ax+b)^n$. After completing that task, they were to do the same inductive process for finding the derivative of $(ax^2 + bx + c)^n$. The goal of the task was for the students to use inductive reasoning to derive the Chain Rule. Peter passed out the directions to the activity, gave some initial instruction on how to use the calculator, and then let the students get to work. While they worked, Peter held individual conferences with students about their test grades.

> PN: This worksheet is an investigation. It should take you about half an hour to do. Before we do that, we've got to teach you how to actually use this new fangle-dangle machine….So, we are going to look, first of all, [at] $(ax + b)^n$. That's what this sheet is about. And then you will do for me, after you have done it in a similar way but at your own way of doing it, $(ax^2 + bx + c)^n$. And what we are interested in is, what is the differential of this, what is the differential of this? The worksheet shows you how to do this; and you can you find a similar style of investigation to figure this one out for yourself. And that will be very individual….This investigation tells you what it wants you to do.

Peter led the students through a quick lesson on how to use the calculator to expand the binomial, differentiate it, and then factor it. Once that was done, Peter sent them off to work on their own or in small groups.

> PN: Now, I want you to go through this worksheet. There's a back to it, as well. Get through that investigation, find a rule, and then do a similar one of your own—devising for $(ax^2 + bx + c)^n$.

The second part of the investigation instructed the students to conduct their own exploration for $(ax^2 + bx + c)^n$ by picking a series of examples so that they could derive the general rule for differentiation.

PN: It might be a little bit more obvious by the time [that they got to the second part of the activity]. It'll be different for different people for the second part, because some of you will get an insight from this one [the binomial], that you'll be able to test this one [the trinomial] pretty quickly. Some of you might need more time to get the pattern. So, I don't want to make those who get the pattern to do a whole lot of busy work just for the sake of it. But I also want to give a guideline for those who need a whole lot more examples before they get what it's all about.

With that introduction, the students began working and Peter began the process of calling up each student to talk about the most recent exam. Throughout the class period, as students were unable to see the pattern, they approached Peter's desk and he gave them some advice or probed their thinking. When some of the students were unable to symbolically represent the pattern that they were seeing, they became frustrated. Peter exclaimed, "Its' an investigation!" to those students who complained. By the end of class, most of the students found the general form.

The two activities, though on different topics, exhibited some similarities. As in the regular class, the lesson in the AP class involved using an inductive process, this time to derive the Chain Rule. The AP students were engaged in some of the same activities in which the regular students were engaged. They followed Peter's procedure for finding derivatives using the TI-89 calculator; they looked for patterns; and then, they applied the general rule to several examples. However, there were some major differences in the way the lesson played out. Similarly to Amanda's, Peter's willingness to stand aside and let his AP students work through the investigation on their own had real consequences for the enacted lessons.

In a comparison of the two lessons, it is obvious that Peter took a very different approach with the AP class than with the regular class. He gave the AP students almost an entire class period to work by themselves on the activity—only providing assistance when they asked. While the AP students worked on the activity, Peter held student conferences. The hands-off approach for teaching the AP class was not like his approach to teaching the regular class, who he led through the investigation. The intellectual processes inherent in the two activities were very similar. Yet, as the observer of the two classes, something seemed very different about the tasks the students were doing. While the AP students and the regular students all engaged in similar tasks—applying procedures, finding patterns, generalizing, and applying a new rule, the AP students were afforded opportunities to engage in all of these activities as an active participant. When it came to the more complex tasks in the lesson, the regular students were by-standers to Peter who did the majority of the work. The AP students were given full responsibility to discover by themselves or with peers. For example, Peter pointed out the pattern of Pascal's triangle to the regular students as opposed to letting them discover it for themselves, whereas the AP students had to find the pattern for differentiation on their own. As in the case of Amanda, Peter provided less experience for the regular students to work independently of the teacher. The AP students, who worked without much aid from Peter, were better encouraged to be autonomous in their thinking as compared with the regular students. This lack of independence had consequences for the students' mathematical experience. Learning opportunities in the two classes were different. The students in the regular class were not given the same opportunities to engage in higher-level mathematics as compared to the AP students, mainly because the regular students' roles were very passive when it came to the more challenging tasks. The AP students, on the other hand, participated in all aspects of the inductive exercise.

The structure of the AP lesson was less rigid than in the regular class. The students worked independently or in pairs for most of the class period, with Peter working busily on another task. When answering student questions, he gave minimal amount of direction. Comparing the two lessons was a much messier task for Peter than for Amanda because I could not be sure that the different topics did not contribute to differences in instruction. However, when I asked Peter how he would teach the chain rule lesson in the regular class, he remarked that he would have to be more involved and he would have to provide more structure.

> I will do it with them. It will be much more directed by me in the regular class. It won't be that sort of, "Here's five minutes of teaching how to use this calculator now get over and explore."

Peter also said that he would not ask the regular students to complete the second part of the activity, where they had to carry out a self-directed investigation of finding the derivative of $(ax^2 + bx + c)^n$.

> I will only do it for linear functions. I won't do it for a power of a quadratic in the regular class, through an exploration, because they won't see the factors so easily. But it could change.

This is an important difference because it was in the second exploration that the AP students not only engaged in exploration, but conducted their own investigation. The AP students had to choose a wide enough sample of examples to ensure that their rule worked for all trinomials of the form. As Peter remarked to the AP class in his introduction of the activity, the students had to decide for themselves when they had done enough examples to make a generalization. Not doing the second portion of the activity meant that the regular students missed out on the intellectual process of conducting an investigation entirely on their own. By scaffolding the activity to the extent that he did, and keeping the regular students from engaging in the self-directed investigation of the quadratic case, Peter provided less of an opportunity for these students to cultivate their independence in mathematical thinking.

The topics in the two classes were different; however, the intellectual integrity of the content was still the same for both classes. That is, the binomial expansion theorem is material that college-bound high school students should be exposed to. Therefore, the content in the regular class is not “basic” or intended for someone on a vocational career track as Oakes (1985) characterized the curriculum in lower-track classes in her study. The intended intellectual processes were similar with both activities providing opportunities for students to engage in similar inductive activities. However, there was a major difference in what actually happened during the two lessons. The regular students were much less actively involved in higher-level tasks than the AP students. This difference could be linked to *lessons learned beyond content* (Oakes, 1985) in that Peter had two very different goals for the classes that went beyond the particular topics of the two lessons. The AP students needed to be challenged and to learn how to tackle an unfamiliar task so that they might be prepared for the AP exam whereas, the regular students needed to be comfortable and to have a joyful mathematics experience their senior year. In trying to cultivate the classrooms in these two very different ways, Peter succeeded in offering different learning experiences for the two groups.

Beyond differences in goals for the two classes, differences in beliefs about students in the classes may have contributed to the differences in teaching approaches. Peter thought that the lower-track students needed more structure than the AP students, because of perceived differences in motivation, behavior, and skill. The AP students required a challenging lesson so that they would not be bored with busy work, and needed to be prepared for the rigors of the AP exam. The regular students, some of whom were lazy and others of whom might become easily frustrated with complex mathematical tasks, needed a classroom experience that was not stressful. Peter acknowledged the presence of some students who were capable of doing more in the regular class. He suggested that there were five or six students that should have been in the AP class given their ability, but who opted out. Overall his attention was focused on not frustrating the majority of the students, who were not as strong mathematically. He focused his pedagogy on ensuring that the average student in the class was successful.

> Now when you come to the other class [regular Calculus] and you're looking at one who's not really struggling, you have a different problem. They're in there and I have encouraged them at the beginning of the school year—that if they're not there, to move to AP. And they haven't got an issue of they're a minority in this classroom. They're not willing to go beyond where you're going, so they shouldn't be the focus. We've got 20 other kids in here and you're going to focus on those. We pay a lot of attention to those who need a lot of reassurance.

Providing a structured, teacher-led lesson for the students in the regular class seemed to fit in with what Peter thought the regular students needed. He saw the need to provide a more structured classroom environment for the regular kids who were often more likely to have behavior problems and to be less motivated. When I asked Peter about his general approach to teaching in the regular class, he suggested that the regular class really did need more structure than the AP class. To provide for this lack of motivation and issues of behavior, Peter recommended the following for teaching the regular class:

> What you have to do is make sure that each step is successful for them. Because they get a certain satisfaction from just being successful. We used to call it giving them busy work. If you had a class where you had a discipline problem, you would turn around, and

you would make minimal steps, and give them lots of practice to give them a sense of satisfaction….But, you also have to strike a balance that you make [it] at least somewhat intellectually challenging so that they do actually have to put forth effort into it. That's where I try to pitch the regular class.

Peter suggested the need for the regular students to feel successful in their mathematical attempts. To do so, he spoke of posing small easily achieved tasks and not pushing them to do anything that would cause the students frustration in their attempts. I observed this approach during the binomial expansion lesson, as Peter was careful in telling the students that finding the general formula would be difficult. Instead of frustrating them, Peter gave the general formula to them. Peter gave the regular students smaller tasks based on concepts that they already knew, such as, finding the expansion of $(a+b)^3$ using the distributive property. He also ended the class by giving the students several practice problems on using the binomial expansion theorem. There was a clear structure to the class that consisted of Peter introducing new material, the whole class working on a practice problem together, and then the students working individually with Peter offering assistance as he walked around the classroom. Breaking up the class in these small controlled chunks, where the regular students experienced limited time to work individually allowed Peter to control for the behavior issues that he expected from these students. This method of teaching also kept the students from being overly frustrated, because as soon as they finished one of these small manageable tasks, Peter gave them the answer and went over the solution before moving on to the next concept.

The approach with the AP students, who Peter described as unwilling to do busy work, was different. The students went for long periods of time working by themselves without Peter's input. Peter's approach with them, at least during the activity that I observed suggested that he only intervened when students came to him for help. When they did, he often encouraged them to keep working on their own. Peter was unafraid of making the lesson too complicated or frustrating these students, and allowed for greater independence in the AP class.

In summary, the lessons learned beyond content (Oakes 1985) for the AP students seemed to revolve around building confidence in tackling new and unfamiliar tasks as well as independence, whereas for the regular class the lessons seemed to be about being comfortable in doing mathematics as well as seeing mathematics as an understandable process to not be feared. While not altogether contradictory goals Peter's instruction where influenced by these two goals, which in turn had important consequences for the type of mathematical activities that the students were involved, possibly providing different learning experiences for the two groups of students.

Kerry. Kerry's two classes offered a comparison of a lower-track mathematics class with a middle-track class, though with more advanced content. I observed Kerry's Algebra I class—considered lower-track because the students in the class were either ninth graders, older students who were taking Algebra I for the first time because they had to take Pre-Algebra in ninth grade, or, who had taken Algebra I previously but failed it. The primary reason for classifying Algebra I as a combination middle- and lower-track class is that most of the students in the class would go on to earn a Technical Prep diploma—the lowest diploma, or a College Prep diploma—the second-lowest diploma. The second mathematics class was the College Prep Advanced Algebra and Trigonometry class. However, since the course was not the top-tier course (there is an Advanced College Prep Version), I characterized it as a middle-track course.

Oakes (1985) talked about discrepancies in content between higher-track and lower-track mathematics classes as follows:

> The knowledge presented in high-track classes in math, as in English, was what we would call "high status"; it was highly valued in the culture and necessary for access to higher education. Topics frequently listed included mathematical ideas—concepts about numeration systems, mathematical models….In contrast, lower-level classes focused grade after grade on basic computational skills and arithmetic facts—multiplication tables and the like.(p. 77)

Oakes went on to say that the mathematics learned in the lower-track classes, while useful, was not considered knowledge needed to go to college. The typical useful mathematics included such topics as consumer math and measurement.

I did not see such a distinction between the content in Kerry's two classes. The Algebra I class did not focus on simple mathematics that one might need to be a productive citizen but not necessarily to go to college. Instead, the mathematics that was covered in the class was typically what we would expect from an Algebra I class—linear functions, solving multi-step algebraic equations, slope, and graphing. However, the broader content—that is the knowledge students were learning about mathematics—was very different in the two classes. Kerry described the content of the Algebra I class as follows:

> We're actually doing chapters 1 through 6 in our Algebra textbook—is what it translates into. We want them to be proficient in operations—order of operations with integers, and fractions, and decimals, and so on. We want them to be able to solve an equation of any type—first-degree equations. We want them to be able to graph lines, talk about parallel, perpendicular, slope of the line. And be able to interpret that—as in they can read a graph, talk about the slope, and the intercepts. Or, given the slope and the intercepts, graph the line. We want them to be pretty fluent in that area of study. That also entails a

> lot of other smaller things—like solving for a particular variable, being able to use real life information to create scatter plots.

Kerry and her colleagues, who were also teaching Algebra I, had a pretty well-developed list of the mathematical skills that the students needed to learn. Their curricular focus was in response to the school's failure rate in Algebra I. Thus, Kerry listed off several topics and procedures that students needed to learn during the class. Later, she added students needing to be flexible in their ability to answer questions.

> We also make about half the test multiple-choice. That's a real art in and of itself. In Algebra Ia, they don't have to take the end of course test—that doesn't come until Algebra Ib. But, we want them still practicing up on all those kinds of questions. We have them writing….I ask a lot of questions that are backwards-thinking kinds of questions. "Create a situation so that, create a two-step equation so that the solution is *x* equals 2." Instead of me giving them the two-step equation only and asking them to answer. So, we question in all kinds of different ways. Convincing folks that the questioning technique is not just a flat, cut-and-dried, "here you go". Need to have them fluent in their ability to look at things.

In the interviews, Kerry described how the questioning techniques that she used in Algebra I were influenced by the types of questions the students would have to answer on the end-of-course test. Kerry had a fairly definite list of things that students in the class needed to be able to do in order to successfully pass the exam.

In contrast, Kerry talked about her goals for the Advanced Algebra and Trigonometry class in terms of a desire for students to be able to do more than just a list of procedures and skills. Instead she wanted those students to gain a broader and more intellectual mathematical disposition which would serve them well in college.

> I want them [Advanced Algebra and Trigonometry students] to really have developed a confidence about pulling together the algebra that they've been studying for all these years, along with the geometry. That's what the first part of the course is—the advanced algebra part. There's very little brand new information. It's all let's just approach it from a more integrated approach, if you can call it integrated. It does take the algebra and geometry and mold it together, [but] not in truncated little units. It seems to be a graphing theme. And can we move from lines to second-degree functions to third-, fourth-, eighth-degree functions—whatever the case may be. Can we talk about domain and range, roots, increasing, decreasing, end behavior? What is a graph of this type? Do you have a sense of what it would look like? We want them to have a more pulled together look of what algebra is and how they might use it.

Kerry's description of the curriculum for the Advanced Algebra and Trigonometry class was different from the curriculum in the Algebra I class, because she was not as concerned with the students learning procedures. Instead, she wanted them to develop a global view of the mathematics that they had already learned. She described that the curriculum for the Advanced Algebra and Trigonometry class had the dual purpose of helping the students to pull together the algebra and geometry done previously, and to provide a strong foundation for the mathematics they would take in college.

Kerry talked about the content in the Advanced Algebra and Trigonometry class as preparation for future mathematical endeavors specifically those at a four-year college. She talked about providing those students with a more holistic view of mathematics. On the other hand, the content of the Algebra I class seemed much more short-sighted with the major goal to teach the students what they need to pass the end-of-course test. These differences in goals for the two classes make sense given the placement of the course in the students' high school career. The older students would better understand a broader view of mathematics given that they would have already taken at least three high school mathematics courses. But, the difference is somewhat reminiscent of the distinction between the higher-track and lower-track classes described by Oakes (1985). The content in the Algebra I class is definitely "useful" in the sense that is what the students needed to pass the end-of-course test. Outside of preparing them for the test, Kerry did not talk about providing the Algebra I students with a good foundation for successive classes such as Geometry, Algebra II, or Advanced Algebra and Trigonometry. Nor did she talk about lessons that would help students see mathematics holistically as she did in the Advanced Algebra and Trigonometry class.

Outside of content, Kerry suggested differences in the processes to which the groups of students where able to engage in. For instance, the Algebra I class was less likely to share answers or solutions to problems as a whole class as well or in small groups.

> Algebra I, by the nature that many of the students will be ninth graders and the other students will be repeating students; it is an immature behavior situation often. So instruction there, hopefully, goes each day, where sometimes I put them in small groups, but I'm much less apt to put them in small groups to work. I give them the little white boards where they can respond to me. But, they don't have to say their response, because once they start yelling things out, then they'll start calling each other names. You know, you even saw some in geometry today, where people were presenting at the overhead, and people were saying things to them about how they wrote the 4. And a little bit of that

> is cute, but it just gets way out of hand way quickly. So, it really does change—the white boards have been a real life saver….So, behavior really does change how sometimes what you think the best approach to learning might be. I don't know that that means you give up on best practices.

Instead of pushing the students to work collaboratively, Kerry gave them white boards to write their solutions to problems. She promoted their working independently for several reasons—one, so that behavior issues would not get out of hand, but also to ensure that each student was actually working.

> I try to have a firm mix of hands-on manipulative kinds of things or even sending people to the overhead with, "You are going to have to stay in your seat and work on your own," in Algebra I. I try to balance those things. In Algebra and Trig, very often, not so much with this group because I've got so many, but I often let them work in groups. They are accountable. If they're working in a group, they're not just copying from somebody. They are trying to learn and use each other as tutors to do that. It's very effective—a very effective instructional tool. Whereas when I put them in groups today in Algebra and Trig, I mean Algebra I, I had one group that just couldn't function at all. Often they won't talk to each other in a group.

Kerry suggested that she is less likely to allow the Algebra I students to work collaboratively, because they do not know how to work effectively in a group, unlike the Advanced Algebra and Trigonometry students, who benefit from the activity. Kerry's rationale for reserving smaller group-work for the Advanced Algebra and Trigonometry students supports Oakes' (1985) findings. Kerry, similarly to the teachers of lower-track classes in Oakes's study, reported that the students in Algebra I lacked discipline and the ability to work well with others. Kerry's beliefs about potential behavior issues, as well as, the students' tendencies to copy from each other influenced her decisions to discourage group activity in the Algebra I class.

I observed Kerry's teaching of the two classes over a two-week class period. Unlike Peter and Amanda, I saw no major difference between Kerry's approach to teaching the higher-track, Advanced Algebra and Trigonometry students and the lower-track Algebra I students. As she claimed, Kerry only allowed Algebra I students to work individually; however, working independently was encouraged in the Advanced Algebra and Trigonometry class, too. In each class, Kerry reminded the students to work on their own and to not share answers with each other.

Encouraging the students in both classes to work individually is only one of the similarities in instruction that I observed. Over the two weeks that I spent in Kerry's classroom, I saw few qualitative differences in content, intellectual processes and lessons taught outside of mathematics between the lessons in the two classes. The differences in instruction that I did see seemed to favor the Algebra I students as Kerry used a variety of methods of teaching, taught for conceptual understanding of the concepts, and pushed students to think about concepts in different ways by posing open-ended tasks. I did not observe the same focus in her Advanced Algebra and Trigonometry class.

Both classes began with a test prep activity—that is, several review questions from the previous days' work in preparation for an approaching unit test. Students volunteered or Kerry asked them to put the answers to the test prep activity on the overhead. Kerry led the students through a discussion about solutions. She guided these discussions, but incorporated input from the students. For example, the following is from a transcript of my observation of the Algebra I class:

K.M.: Okay, now remember, we talked about slope being the tilt of the line. Can somebody tell me, without knowing a numerical value for slope yet, anything about the slope of this line?

Kerry paused while students answer.

K.M.: Alright. I heard a couple of things. It's going from left to right, so it's going uphill. I heard it's positive. How do we know it's positive?

Student answered that they could tell because the line was going from left to right.

KM: When it's going left to right. When you're reading left to right, it's going uphill. Alright. Now, is this going to be an extreme. I mean, is this going to be a number larger than one—kind of slope? Or, do you think it's going to be a number-less-than-one kind of slope?

Students did not respond.

KM: Okay. Let me see if I can say that better. I'm trying to lead us to how do we know or have a guess or a feel for whether the slope is more than or less than one? And we said, "It needed to be positive." Is this a gentle slope or is this a real steep slope?

Student said that it was a gentle slope.

KM: You think it's pretty gentle? Or right in the middle? Or something like that. We talked about—what was the slope of that line that was extremely steep yesterday?

A student motioned with his hand that the line was almost vertical.

KM: And what did we call that? Vertical, right. It was almost a vertical slope. So remember as the numbers get larger and larger, the steeper and steeper the slope is.

Kerry's role in this discussion class fits in nicely with her view of the role of the teacher as a guide. She led the students through determining the slope of the line just by looking at the graph of the line, but without knowing any points on the line. Her approach to guiding the students, however, incorporated student input. Along the way, she asked questions. These questions were low-order, product questions such that students were expected to give answers as opposed to reasoning (Everston, Anderson, Anderson, & Brophy, 1980). But, they were an integral part of her teaching. While she provided the overall frame for the discussion, she counted on students to fill in details. Students took this role in the Algebra I class and the Advanced Algebra and Trigonometry class. Kerry led the discussion, but asked low-order product questions requiring students to give short answers, such as, the next step in a procedure.

I observed Kerry's use of various instructional techniques and tasks with her Algebra I students that she did not use with her Advanced Algebra and Trigonometry students. However, I refrain from suggesting that there was a hierarchical difference—that is, that her teaching was better in one class than in the other for two reasons: First, during the two weeks that I observed her teaching, the Advanced Algebra and Trigonometry class was at the end of the unit and preparing for a test. The first lesson that I observed was devoted to going over homework from the previous night. The next day, the lesson was a review. The next day was a test day. There were also days where Kerry went over the test and re-taught the same material. I never saw the introduction of new material. Much of what I know about how Kerry taught in that course is based on the description that she gave to me during the interview.

The content in the two classes was what might be expected in any Algebra I class or Advanced Algebra and Trigonometry class. In the Algebra I class, the content included topics dealing with linear functions such as slope, the relationship between tabular, graphical representations of a linear function, and the coordinate plane. In Advanced Algebra and Trigonometry, the content included: finding coterminal angles and then using the unit circle to find the exact value of secant, cosecant, and cotangent. There was no stratification in content such that the lower-track students were learning a lower grade of mathematics while the college-bound Advanced Algebra and Trigonometry students were learning higher-level mathematics. The content in both courses, though different, was “high status” (Oakes, 1985) mathematical knowledge. There was no difference in intellectual processes expected of the students, either. In general, the students were expected to follow along in the discussion and then apply whatever new procedure was learned to a series of problems.

The focus of one of the Algebra I lessons was finding the slope given a graph of a line. Kerry described that the goal this lesson was for the students to develop a flexible understanding of slope, familiarity with the different representations of linear functions, and understanding the relationship between these different representations. To motivate their understanding of slope, Kerry instructed the students to first, approximate the slope of a graphed line using the slope of a vertical line as a point of reference. Then, students were divided into groups to find the slope of the line in question. To illustrate this point that the slope was constant for a linear function, Kerry gave each group of students a different pair of points on the line with which to calculate the slope. Kerry offered that there were at least two ways that the students could find the slope—using the formula for slope, or counting grid lines. Students were instructed to choose their preferred method. This portion of the lesson focused on the promotion of a more conceptual understanding of slope. Kerry also pushed students to think about abstract generalizations. Though her instruction was teacher-led with some student input, the main focus of the lesson was the transition from the concrete to the abstract. First, Kerry instructed students to label given coordinate pairs on the coordinate plane and then changed the question by giving them a quadrant on the coordinate plane and asking them to think come up with a point that would lie in it.

KM: How do we know—let's look at the first one. How do we know that a particular ordered pair is going to land in the second quadrant? What's going to be true about every ordered pair in the second quadrant?

Student: It's going to be a negative number.

KM: It's going to be a negative number and then a—

Student: A positive number.

KM: Positive number. Did everybody do that? On number one you would have had a negative number, and then a positive number. And you know what? It doesn't matter which way it goes. I mean, it doesn't matter what numbers they are. You could have –5 and 8 million. You could have negative 10 million and 1, as long as you have a negative and then a positive. Can you have a zero anywhere and land in the second quadrant?

Students: No.

Kerry: No. What about at the origin? Everybody should have written—

Student: (0,0).

KM: (0, 0). Third quadrant—what's going to be true about an ordered pair in the third quadrant?

Student: Both negative.

Kerry: They both have to be negative. What about the *x*-axis, what will they all look like?

Kerry moved the class towards making generalizations about the relationship between the quadrant in the plane and the sign of the coordinates of a point in that location.

Similarly, Kerry pushed for conceptual understanding in Advanced Algebra and Trigonometry, too. Dissatisfied with the way the text introduced the unit circle and it's use in finding the sine, cosine, and tangent of reference angles, Kerry motivated conceptual understanding of the concept with an activity that related the unit circle to the inscribed 30-60-90 triangle. Though I was not able to observe the introduction of the new material, Kerry described the lesson to me during one of my observations of her class.

> Kerry: The book—I don't like how they set this up. This is actually the first section in the chapter. But, what I do is skip over here to right triangle stuff, because they are pretty much familiar with that. And then we go into the applications, and then we go back and we draw that right triangle in the coordinate plane, and then we do the unit circle stuff. We come back to the unit circle....What we did is, we had developed 30-60-90 and 45-45-90, so we had them, and we made them be a unit long, and that's how we found the ordered pairs….At least it's more visual, and at least they understand where it came from. It took me until I was in college for me to figure out where those things came from.

Using cutouts of the right triangles, placing them on a coordinate plane, and inscribing them in a circle, Kerry provided a reference point for the sine, cosine and tangent of angles with degree measures 30, 60, and 45. During the lesson that I observed, Kerry referred students back to this exercise when they forgot the sine or cosine of one of the angles in question. As in the Algebra I class, the content was more than just procedural knowledge of how to calculate trigonometric functions, but a deeper understanding of the relationship between the angles in a right triangle, their location on the unit circle, and the corresponding values of trigonometric functions.

The content and intellectual processes were similar in both classes. Students were expected to have a conceptual understanding of mathematical concepts as well as to apply this understanding to procedural problems. They were expected to participate in class discussions and to draw on previously learned material. The one difference that I did notice between the two classes was Kerry's use of a variety of instructional methods in the Algebra I class but not in the Advanced Algebra and Trigonometry class. However, as the lessons observed in the Advanced Algebra and Trigonometry class were not typical, in that they were review-based, I cannot be sure of the different types of instructional methods used in that class.

Kerry did indicate that she used certain instructional strategies with her Algebra I students because of their particular needs. For example, she used small dry-erase boards because the Algebra I students were less confident and unwilling to look dumb in front of their peers and in front of her. She said of the successful use of the boards in class:

> Even the students that put their heads down will suddenly perk up and write on there. And I'm going, "Okay." [Laughs]. They think that when they turn around and show me, that their just showing me [their solution]. I'm not sure that they realize that the other students can see what they did. But, they're focused on me. It's almost like, "Mama did I do this right?"

During the Algebra I lesson, Kerry passed out the dry-erase boards to each student. One side was blank and the other had a coordinate plane. Kerry had the students do several activities on the board—one was to fill in a tabular representation of a linear function on one side of the white board and then to graph it on the other. Kerry initially gave them *x*-values so that they had to find *y*-values and then graph the line. The second time, Kerry gave them the equation but had them choose *x*-values, find the *y*-values, and then graph. Once completed, Kerry instructed the students to hold up their white boards with the graphs of the lines. The idea was to illustrate that though they all used different points; they got the same graph of the line. The purpose of the work on the white board seemed to be to get the students to become more confident in sharing their answers with the entire class. In our interviews, Kerry described her concern with having her Algebra I students vocally share answers because it might incite criticism, cause name-calling, and make the less confident students uncomfortable. To compensate for the discomfort, but to push the students towards the sharing of work, Kerry incorporated the white boards into lessons.

Literature suggests that lower-track mathematics classes often translate into low-level experiences for the students (Oakes, 1985). Often, differences in content or expectations for students in lower-track mathematics classes are tied directly to the teachers' perceptions of the students given their tracked status (Boaler et al. 2001). On one hand, in interviews with me, Kerry described her Algebra I students as less motivated, more disruptive, less able and unconfident; yet, her teaching of these students was not much different from her Advanced Algebra and Trigonometry students who she labeled as college bound, motivated, and bright. Any number of things could account for her offering the same quality of teaching to students whom she deemed different in their future aspirations, ability, and behavior. It could be that she approached teaching mathematics as a constant, such that, it does not change regardless of who is being taught. However, her interview data suggested that she did believe that she changed her teaching depending on who she taught and my observations of the frequent use of the white boards in her Algebra I class support that claim. Still, it is not far-fetched to think that her instruction in one class might influence her instruction in another. Further study into teachers who teach in such distinct tracks concurrently might shed light on the influence of such experiences on their teaching of both classes.

In Kerry's case, the role of the departmental goal of increasing the Algebra I passing rate cannot be ignored. Teaching Algebra I in this context demands holding high expectations for all students. Kerry has to approach her teaching of this class with the idea that the students can successfully pass not only the class, but the end-of-course test which tests both their procedural and conceptual knowledge of algebra. Understanding how external influences, such as, standardized tests demands that teachers hold high expectations for students in lower-track mathematics classes might be another fruitful area of study. Given that my study did not approach this goal of improving the passing rate as more than just context, I cannot overly hypothesize what influence it had on Kerry's teaching of Algebra I.

Discussion and Conclusion

This study began as an attempt to understand how teachers change their teaching practice depending on context and based on what they take to be true about their students. To address this research question, I observed and interviewed teachers about their teaching in two different classroom contexts. The context that I focused on for the purpose of this study differed with respect to the specific race/ethnicity and socioeconomic makeup of the student population in between case comparisons. For within case comparisons, I compared each teacher's teaching of two tracked classes. The teachers were National Board Certified Teachers who had successfully indicated to a panel of evaluators that their teaching followed certain standards, one of which was that their teaching practices incorporated knowledge of their students. I expected to hear in their interviews some amount of talk about how they adjusted their teaching with some acknowledgement of the students' racial/ethnic or socioeconomic backgrounds. What I found was the class's track overwhelmingly influenced the teachers' practice in that class. That is, for each of my participants, what emerged from the interview and observation data was how linked their practice was to the assumptions they held about students associated with their place in the tracking structure of the school. This is not to say that the race of the students did not matter (see the section on Kerry and behavior issues), but the teachers did not see it as being crucial nor did they try to adjust their practice consciously with respect to the race, ethnicity or SES of the students.

In this section, I discuss my findings of this study. In particular, three major points emerged from the intersection of my data and the literature reviewed. The three main points that emerged from the data are:

1. Even thought Oakes's (1985) study was conducted several decades ago and we now include more students in "college bound" classes, her findings on the ills associated with tracking remained true in classrooms of two of my participants—particularly those that were teaching all college-bound students.
2. In the between case comparisons, regardless of the racial/ethnic or socioeconomic context of the school, all three teachers held similar views about their lower-level students as compared to their higher-level students.
3. The teachers in my study were not culturally responsive in their teaching practice. Instead they were more responsive to the needs of the students based on their position in a particular track.

Shifting up. Tracking has changed over the past several decades since Oakes (1985) conducted her study on tracking in US secondary schools. Today, we see more and more students in "college preparatory" classes. However, the result has been a phase shift upward with the same ills associated with tracking in the 80s being reproduced today, but with respect to different classes. All three of my participants spoke about how their schools essentially abolished all vocational classes and instead pushed the majority of their students into college preparatory courses. Making the college bound track inclusive of more students was not a phenomena particular to the schools of my participants. Rather, it simply reflects the larger national agenda to ensure that not just a few are being exposed to high quality mathematics but that every student has the opportunity for high-level mathematics.

More students are taking academic classes as opposed to vocational classes. However, those academic classes are tracked. That is, even if 80% of a secondary school student population is taking courses required for college, they are not all taking the same version of the class. For example, the National Center for Educational Statistics reported in 2003 that over 80% of Black students in the late nineties were enrolled in academic mathematics classes. However, 57% of Black students were in middle-track courses versus higher-track. That is, the majority of students in academic mathematics classes sat in these middle-track mathematics classes such as Advanced Algebra and Trigonometry. Thirty-percent of Black students were in the top-level higher-track classes, compared to 45% of White students and 56% of Asian students. Thus, the racial stratification that Oakes (1985) and others reported with respect to the sorting of students into vocational and academic classes is still present. However, it now appears that the sorting is of students into the middle- and higher-track mathematics classes. Based on my findings, some of the same claims that Oakes made about teachers of lower-track, non-academic classes were being made by my participants about the middle-track academic classes.

For the two participants who were teaching honors or AP versions and also a regular version of an advanced mathematics classes, descriptions of the students in the lower-track classes included their being lazy, not motivated, behaviorally disruptive, and needing structure. For Kerry, the distinction between her lower-track Algebra I students and her middle-track

Advanced Algebra and Trigonometry students is more consistent with Oakes's (1985) findings. However, as indicated in the discussion of her case study, Kerry's views of her lower-track Algebra I students were actually very connected to behavior that is racially marked. That is, her Algebra I students, who are mostly Black, were described as volatile in their behavior, making it harder for her to connect to them. This in turn made it more difficult to teach them as compared to her generally more agreeable Advanced Algebra and Trigonometry class.

Amanda and Peter each taught two classes where the students were more similar than different. The higher-track mathematics courses such as Pre-Calculus and Calculus differed only by the labels of regular versus honors or AP. However, their interviews brought to light how the each teacher thought that the students were so very different. Even though the students in both classes were all likely to go to college, the teachers talked about the differences between the two classes with similar language to Kerry's. Amanda and Peter taught their two classes very differently, electing for more structure and less discovery in the regular classes because they believed the students needed more structure and external motivation. These findings suggested that even though all of the students in Amanda and Peter's classes were considered college-bound and were sitting in advanced mathematics classes, the middle-track students were still experiencing mathematics in a different way.

On the other hand, an interesting and unexpected finding was that Kerry, though she spoke of her two classes as being very different, taught in much the same way. She seemed to hold high expectations and provide high-quality content for her Algebra I students, despite her claim of their lack of motivation, extreme behavior issues, and lack of mathematical knowledge. She was also willing to try different things to motivate her Algebra I students to work and share their thinking. In class, she used white boards for individual student work. One explanation for her approach to teaching the lower-track class might be the goals and accountability system provided by the mathematics department for the Algebra I class. The department was determined to see improvements in the passing rate in Algebra I. This might have had some influence on her teaching of this class.

A lack of culturally relevant instruction. Each of the three teachers talked openly about the ethnic/racial and socioeconomic demographics of their schools. However, their pedagogy did not incorporate attempts to link the mathematics students were learning to the students' background or interests. Peter felt that his Black students were different from typical Black students because they came from middle- to upper middle-class homes with parents who stressed the importance of academic achievement. He suggested that the diversity with respect to race in his classrooms had no influence on his teaching practice. Amanda was the only one who talked about trying to relate the mathematics that the students were learning to their lives and interests. However, she focused on trying to relate it to music as many of the students were also involved in the music magnet program at the school and not to their being Black students living in an large urban area. For example, in one attempt to give students a real-life application of sinusoidal trigonometric functions, she made the connection to cycling. Cycling is not a sport associated with inner city Black students given that cycling is an expensive hobby. In general, while the participants were aware of racial diversity in their classrooms, they did not see it as impacting the pedagogical choices that they made in their classrooms. Instead, the major influence on their teaching practice was the track in which the student was sitting.

Differences in contexts but not in views of students. Boaler et al. (2000) found that the labels associated with tracking influenced teachers to teach all students in a particular track in a classroom in the same way without differentiating instruction for individual students. I found with my participants that these labels stuck with students regardless of the academic environment. That is, it did not matter if the school was a magnet school or if the classes were advanced; those labels of “regular” versus “honors” provoked a comparison in which the regular students were seen as lazy, non-motivated, and lacking direction. I picked three very different schools in terms of student demographics but also in terms of academic standing. I expected that this would allow for a between case comparison such that I might see different results for the teachers. However, what I found was that regardless of the context of the school, each teacher used similar language to compare lower-track class to the higher-track class.

Peter taught at a school that housed an international magnet program as well as the International Baccalaureate program. Many of his students in both the regular and AP Calculus class were actually eleventh-graders. These students were not only graduating with Calculus but taking it their junior year of high school. Peter taught several Calculus classes throughout the school day suggesting 1) that many of Lakewood’s students took this advanced mathematics class, and 2) the majority of students that Peter taught on a given day were in these classes. He was not teaching poor mathematics students. Similarly, Amanda taught in a high school with a music magnet program. Again, while her school offered fewer advanced classes than Peter’s school, she taught only Advanced Algebra and Trig or Pre-Calculus classes. Again, Amanda was dealing with only the top students of the school. Kerry was the only one teaching introductory-level mathematics classes—Algebra I and Geometry I. She regularly taught students who were repeating a class for the second and sometimes third time.

While the lower-track classes differed in content for Amanda and Peter from Kerry’s classes, all three teachers reported very similar characteristics of their lower-track mathematics classes. This is interesting because it suggests that tracking labels overshadowed the academic reputation of the school and the students. In Peter's case, the students in his regular Calculus class might have been considered top students in another, less rigorous school. However, in comparison to the real top students of the school—those in the AP Calculus class–the regular Calculus students might just as well have been taking a lower-level mathematics class.

Why care? The key findings of this study were that my participants were influenced by their students' placement in a particular track. Similar differentiations between tracks seen by Oakes (1985) in the early 1980s appeared in my study, as well. However, as we have moved to less exclusivity in who can take advanced academic mathematics classes, the strict division between students meant for vocation and those meant for college is blurry. My participants were all teaching classes, that during the time of Oakes' study, would have been considered academic or college bound classes. Yet, her claims of teachers of lower-track mathematics classes being more focused on issues of behavior and discipline were vividly present in my study. So while we may have progressed in making mathematics for all, the result has been a shifting up of the differentiations between students that Oakes (1985) found happening between vocational and academic students. She claimed that there was not much difference between middle- and high-track classes—particularly with respect to mathematics. These classes were taught with similar goals and instructional approaches. However, in my study, this did not hold true. None of the classes observed were vocational (although Kerry's class Algebra I class could have led to a technical preparation diploma if students did not successfully complete enough mathematics classes for a college preparatory seal). The completion of all of the courses could potentially lead to a college preparatory diploma. The teachers still made strict divisions between the middle-track and higher-track classes. They spoke about the students differently, and they taught the material differently. The important question becomes, is simply minimizing vocational or technical tracks in secondary schools such that the majority of the students are in so-called college-bound classes really the answer to providing all students high quality mathematics? The data collected from my three participants suggest that differentiation in instruction, goals, and expectations still exists. With more of the students sitting in middle- and higher-track mathematics classes, it is no longer worthwhile to study tracking strictly in terms of differences between technical/vocational-level and honors classes. Instead, we need to look more closely at those differences between higher-track and middle-track classes. The tendency might be to assume that there is no difference between the two levels of classes and to be content with the fact that at least the majority of secondary students are in college-bound academic mathematics classes. However, the mathematical learning opportunities might be different depending on the track of the class. In particular, given that 57% of Black secondary students are sitting in these middle-track classes, with 30% sitting in higher-track classes, it is necessary to look critically at these middle-track classes to determine if all students are being provided meaningful opportunities to become mathematically proficient. Looking at the goals and expectations teachers of middle-track students hold, as well as the resulting instructional practice, might shed some light on racial disparities in achievement.

Chapter 5
Discussion/Conclusion

This study started out to be about teacher knowledge of students and ended up being about differentiation in expectations for students in differently tracked classrooms. The research questions that guided this study were as follows:

1. What knowledge of students do teachers use to inform their teaching practice?
2. How does that knowledge influence their teaching practice?
3. What role does the race or culture of the students have in that knowledge of students?

In an effort to collect qualitative data to investigate the three research questions, I devised a methodology that would allow me to carefully compare my participants' teaching in different contexts. From this comparison, I hoped to gain insight into how my teachers used particular characteristics of students to inform their teaching practice. I thought, given the accomplished nature of my participants (veteran teachers, holding advanced degrees in mathematics education, and National Board Certified), that these teachers would be reflective on the nature of their students and would incorporate what they knew of their students into their teaching practice. That is, I expected beyond their years of teaching, their National Board Certification status would imply that these teachers were not just teaching mathematics but were teaching mathematics to students. In fact, one participant echoed this sentiment during an interview. I asked Peter if he adjusted his teaching depending on who he was teaching. After thinking for a moment, he said:

> I can't be teaching them all the same, because then one class would not be getting what it needs. So I am adapting, and how I've learned to do that over the years is something which is still a mystery. But it's still a mystery to most teachers.…Right, I must have spent at least the first 10 years of my career just teaching. That explains why I had such disastrous time for the 10 years. It took me about 10 years to learn to get enough of a grip of what was going on with the kids to get out of teaching-the-subject mode. And saying, "Oh no, they've got to learn it." Well, they can't if you're not adapting to them as well. They do have to learn it....When you go down look down your class list these days, it's a different attitude. You're not saying, "Is this child being successful?" You're going down and saying, "What do I need to do for this student?"

Peter described exactly the concept I hoped to address in my study. How and based on what do teachers change their teaching practice depending on who they are teaching?

I cannot be too surprised that my results suggested that the teachers were overly invested in the tracked status of their students. My methodology of comparing two tracked classes necessarily imposed the distinction on my participants. In other words, I could hardly expect that my participants would not answer the question, "How are the two classes different?" without some reference to tracking. However, in purposefully picking schools with diverse school populations (except for Amanda, whose school was 85% Black), I expected that other student characteristics would emerge that the teachers saw as influencing their teaching. Although each teacher could tell me about the diversity between his or her classes (even Amanda, whose honors class and regular class differed greatly with respect to gender), none saw that this diversity played a role in their teaching. What kept coming out of the interviews was the association between the track and the student characteristics. All three participants made clear that the lower the track, the less motivated and more disruptive the students. The higher the track, the more motivated, self-directed, and agreeable the students were. And these associations had direct consequences in the ways in which the participants taught their classes.

I used literature on tracking and on teachers as decision makers to frame my study. The tracking research provided a necessary context on which to base my study—particularly the Oakes (1985) book that reported data from the 1970s. It was important to use that study especially as a guide for my study because of its comprehensive inquiry into the inequitable differences in the educational experiences of high school students in schools that used tracking practices. Although not as comprehensive, I hope that my study sheds some light on how the story of tracking in American high schools more than 20 years later has evolved. Oakes found that in all mathematics classes, regardless of track, students were not actively involved in classroom activities. She observed teachers lecturing and students taking notes. While I would not be so bold as to make the claim that mathematics teaching in general has shifted away from this form of teaching, at least my participants demonstrated teaching where the students were more actively involved. Further, Oakes compared vocational or technical preparatory classes to college preparatory classes. It would hardly be worthwhile to do such comparisons today, given that 80% of US students are taking academic classes currently (Hoffman et al., 2003). It is more important to look at differences between the average- or middle-track classes and the top-track classes. With 57% of Black students sitting in middle-track classes, those interested in the racial disparities associated with tracking must begin looking in those classes. My study brings to light how distinctions similar to the ones Oakes found teachers making between top-track and vocational-track students are made between top-track and middle-track students, even though they are all college bound.

I used the literature on teachers as decision makers to frame my study because I thought it important to regard teaching practice as an informed struggle between competing priorities (Skott, 2001). Skott (2001), Patori (1994), and Patori and Jaworski (2002) all point to the need to understand teaching in terms of competing priorities—those influences, mathematical and nonmathematical, that pull on teachers to act in a certain way while teaching. Each of these studies looked at teachers who professed one ideology of teaching but slipped into another during the actual practice. Understanding all of those competing priorities that teachers must struggle with in a given moment of instruction provides for greater understanding of certain decisions. In particular, the associations made by my participants about their students and their respective tracks helped me to better understand the instructional choices they made. Further, it pushed me to think beyond any initial judgment I might have had of their teaching.

All of my participants were veteran teachers truly dedicated to ensuring the success of their students. Amanda knew that teaching in an inner-city school might be difficult but chose her school purposefully and stayed because of her love for her students. Kerry spearheaded a department imitative to revamp the way that her department taught Algebra I, and Peter, with a PhD in mathematics education, chose to come back to the high school classroom after a short stint teaching teachers at a college. The decisions that they made with respect to teaching their students were purposeful and well intended. Knowing their students in each class, they acted in ways that they felt would help their students succeed. However, they were heavily influenced by the tracking structure of their school (Boaler et al., 2000). Tracking and what my teachers believed about their students based on tracking influenced their pedagogical decisions.

If we look at the case of Amanda, we see a teacher who has an image of good mathematics teaching as discovery based, with the teacher moving aside to let the students do the mathematics. She regularly employed such methods during both classes. However, in the lesson presented in this study with the regular students, she adjusted her teaching style and instead chose to take more of a lecture approach once she felt that the students were off task or unable to complete the assignment. Her priority (Skott, 2001) at the time was to make the connections for the class when she felt that they would not be able to. Although this decision was partly based on what transpired in the classroom, some of it was based on her ideas that the regular students could not handle such an open-ended exercise and needed guidance. I hope that the results of this study contribute to the literature on teacher decision making as it adds the component of labels on students based on tracking. The influence of beliefs about students based on tracking was missing from the mathematical and non-mathematical influences on the teacher discussed in this literature.

Summary of Findings

From the within-case comparisons, I found that above any other characteristic influencing my participants' adjustment of teaching practice, the tracking label was the most influential. Rarely did my participants talk about a particular student unless the description served only to reinforce their ideas about the class as a whole. That is, the differentiated teaching was happening but not on an individual student level, but rather in terms of the whole class. Even if the classes were diverse with respect to race, gender, age, or socioeconomic status, the students in the entire class were mostly placed into the category of honors-, regular-, and low-track student.

The between case comparisons suggested that regardless of the social context of the school—rich or poor, White or Black, magnet or non-magnet—each participant made nearly the same claims about the differences between their lower-track and higher-track students. Further it did not matter if the lower-track students in the comparison were actually college bound students taking an advanced mathematics course or in Algebra I for the third time. Across the cases, the lower students were seen as the more behaviorally inept and less motivated.

Implications

There has been a great deal of criticism of tracking, especially with respect to it being an inequitable practice. There has been some research on how to effectively teach mathematics in nontracked secondary schools (see Boaler, 2006). However, by and large, tracking will most likely remain the dominant method of structuring high school courses in this country. On the positive side, with more students in academic track classes, even if they are regular classes more students are being exposed to higher level mathematics than ever before. However, we still must be mindful of the problems associated with tracking in this albeit new era of education. Although the context has changed—that is more students taking academic classes and fewer taking vocational classes—we have to ask ourselves whether that change means that every child not in the top-track is now receiving the same high-quality mathematics education as his or her peers in AP or honors-track mathematics classes. Typically the point is made that teachers of students in lower-track mathematics classes are less qualified (Oakes, 1985), and so the students in that class receive a lower-quality education. One suggestion might be to assign higher-quality teachers to those lower- or middle-track classes. A teacher with greater content knowledge, more experience, and more expertise would presumably provide these students with a better learning experience. My study suggests that the solution is not that simple. Although the high-quality teachers in this study might provide lower-track students with better learning opportunities than a teacher without such credentials, it seems that they would not necessarily provide these students with the same opportunities as those students in higher-track mathematics classes. Therefore, it is not enough for schools to suggest that they are bypassing the inequity issue in tracking by making every good teacher teach one Algebra I class along with AP Calculus. It is not a given that because a teacher provides rich and engaging mathematical tasks in AP Calculus that he or she would do the same for the students in Algebra I.

It is very difficult for students to move from one track to another once in high school (Oakes, 1995). As Peter, one participant, suggested of his district, the rigid placement in a track began in middle school. Realistically, once a student is in middle school, he or she may be branded for the rest of his or her schooling as a low-, middle-, or high-track student. If this label affects the opportunities provided for the student, it is crucial that he or she be placed in their appropriate class. However, we also know that the procedure for tracking is fluid (Oakes & Guiton, 1995), with students being placed based on an assemblage of factors—past achievement, teacher recommendation, parent persistence—suggesting that it is not always ability that ensures a student in a given track. Given the potential impact on students' opportunities for learning, secondary schools should make for an easier movement of students from track to track.

Finally, there is a continual need to provoke teachers' thinking about their own prejudices and biases and how they affect expectations. There has been a great deal of research on preservice teacher education on this topic with special attention to racism (see Marx, 2001); but as a community, mathematics educators need to address how to help inservice teachers reflect on and address their biases, which in turn influence their practice. My study suggests that the participants were not at all critical of their characterizations of their students based on tracking. The National Board Certification process has an equity requirement in that candidates should demonstrate how their practice is equitable. However, such exercises are clearly not enough. Teachers must continuously reflect on their beliefs about their students. This reflection is probably even more crucial for veteran teachers who have years of experience teaching behind them and enough experience teaching all levels of students to justify strict associations of certain behavior with groups of students.

This study, particularly the case of Amanda, points to the need to address the importance of expectations and issues of tracking in preservice education. Although Amanda had a teacher education experience that seems nearly perfect—a teacher certification program with a focus on constructivist approaches to learning, a bachelor's degree in mathematics, and an internship in an inner city high school—she still fell short of holding high expectations for all students. It is crucial for preservice secondary teachers who will most likely be teaching in a tracked high school to address and reflect on the problems of tracking while in preservice education. One suggestion might be to use some of the reflection activities that are done with preservice teachers in conjunction with their internships on issues of race (Marx, 2001) but with a focus on tracking.

Future Research

I reiterate an earlier point that researchers interested in issues of tracking need to look more intently at those middle- or average-track mathematics classes. The majority of students are being placed in these classes because of school policies to get rid of vocational and technical preparatory classes. It might be interesting to study whether these students really are being prepared to go to college. In an interview, Amanda suggested that most of the students in her regular class would end up in the remedial mathematics classes in college. Is that what the middle-track is a pipeline for—re-taking high school mathematics as a freshman in college?

Finally, it is interesting that Kerry, the participant who talked the strongest about differences between her two groups of students—Algebra I and Advanced Algebra and Trigonometry—was the only one whose practice resembled the purpose of ability grouping.

Ability grouping, tracking, or streaming are all about providing differentiated instruction to students because of differences based on ability. Kerry seemed to be the only participant to do that, as she tried several instructional methods based on her students' abilities. She also held expectations that the students would be able to do high quality mathematics associated with the end-of-course test. Another interesting line of research could be to look at the impact of such accountability standards on instruction in tracked classrooms. How do differences in tracked classrooms look in the era of No Child Left Behind? How do Adequate Yearly Progress guidelines affect what is expected of all students, including those in the lowest track?

I conclude with a quote from Jeannie Oakes and Amy Stuart Wells written in 1998:

> Standards reform in the United States aims at providing all children with a more challenging curriculum and holding schools accountable for their achievement. High academic standards, proponents argue, will alleviate inequalities in curriculum, instruction, and expectations for students. Purportedly, standards will also bring excellence by requiring all students to demonstrate higher levels and by providing all students with equal educational opportunities while preparing a more informed citizenry and a better trained work force. But what about the firmly entrenched system of tracking that exposes students to dramatically different and unequal levels of curriculum? (p. 39)

Though the participants in the present study were teaching in schools where the types of lower-track classes Oakes and Wells are referring to have all but faded away, with the majority of students taking at the very least lower-track academic classes, the statement still poses a relative point. Can we really ensure that all students are receiving equitable opportunities for learning mathematics in a tracked structure? If we cannot rid secondary schools of tracking, then we have to spend time making it better. We have taken one step in the right direction by including more students in college bound academic classes, but this cannot be the endpoint. As this study shows, readjusting the tracking system to reflect the idea that all students should receive high quality mathematics without ensuring that the experiences between tracks are equitable further exacerbates the original ills associated with tracking.

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