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ACCEPTANCE

This dissertation, A MATHEMATICS ACCELERATION EXPERIENCE FOR MATHEMATICALLY PROMISING STUDENTS, by DOROTHY JEANETTE WHITLOW-MALIN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

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ABSTRACT

A MATHEMATICS ACCELERATION EXPERIENCE FOR
MATHEMATICALLY PROMISING STUDENTS
by
Dorothy Jeanette Whitlow-Malin

To address the pervasive concerns of educators about the social and emotional effects of mathematics acceleration on students and the paucity of findings on those issues, 6 students who had participated in 6 years of accelerated mathematics courses were purposefully identified and interviewed in this longitudinal study. Through a qualitative research design, using phenomenological methods, and accompanying descriptive statistics, the author elicited the students' descriptions of their learning experiences. Major findings in this study were that all students described great benefits from the experience, negative effects were minor, and key factors contributing to success were work ethic, motivation, parents and teachers. The researcher examines a subset of able and promising students who experienced increased mathematics expectations, and she gives parents, educators and policymakers insight into how that population responded to those challenges. In the ever-shifting arena of higher learning expectations for all students under No Child Left Behind legislation and the poor showing of U.S. students on international tests, these results provide information about the possible responses that other students, those struggling and unmotivated, might have to those demands.

A MATHEMATICS ACCELERATION EXPERIENCE FOR MATHEMATICALLY PROMISING STUDENTS

by

Dorothy Jeanette Whitlow-Malin

A Dissertation

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in
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2006

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TABLE OF CONTENTS

Page

List of Tables v
List of Figures vi
Abbreviations vii

Chapter
1 INTRODUCTION 1
Background 1
Rationale 8
The Problem and Purpose 9
Guiding Research Questions 10
Significance 10

2 METHODOLOGY 13
Theoretical Orientations 13
Researcher as Research Instrument 21
The Research Design 32
Transcription, Analysis, and Coding 43
Validity of the Data 46

3 FINDINGS: STUDENTS' EXPERIENCES IN THE ACCELERATED MATHEMATICS PROGRAM 51
Gregory 51
Darren 61
Robert 66
Carla 73
Janine 83
Lisa 91
Surveys 97

4 THEMES AND TRENDS 103
Courses Taken 103
Postsecondary Plans 106
Definitions of Success 108
Factors Contributing to Success 110
Perceived Benefits 119
Negatives Associated with Participation 120
Students' Descriptions of Self 122

Levels and Sources of Challenge and Ease....126
Peers....131

5 CONCLUSIONS....140
Limitations....140
Conclusions....141

References....145

Appendixes....150

List of Tables

Table Page

1 Criteria for Participation in seventh grade Algebra I Program 28

2 Comparison of Course Placement in Advanced Program and Hyper-Accelerated Program 30

3 Comparison of Grades Obtained in Courses.....98

4 Satisfaction with Experiences in Courses 98

5 Means of Satisfaction with Geometry (eighth grade) 99

6 Means of Satisfaction with Analysis (10th-grade).....100

7 Frequency of Responses to Positive Benefits and Negative Effects.....100

8 Ratings of Algebra Backgrounds and Geometry Backgrounds 101

9 Ratings of Enthusiasm for Mathematics 102

10 Student's Reported Earned Grades at 10th-grade-level and at 12th-grade-level 107

11 Accomplishments as Measures of Success 109

12 Factors Contributing to Students' Success 111

List of Figures

Figure Page

1 Flow Chart of Research Methods 44

ABBREVIATIONS

AP	Advanced Placement
NCTM	National Council of Teachers of Mathematics
PDK	Phi Delta Kappa
SMPY	Study of Mathematically Precocious Youth
TIMSS	Third International Math and Science Study

CHAPTER 1

INTRODUCTION

U.S. schools developed the first programs of acceleration in age-graded schools more than a century ago (Colangelo, Assouline, & Gross, 2004). St. Louis, MO, public schools began the earliest program of flexible promotion in 1862. Kulik (in Colangelo et al., 2004) reported that studies of acceleration carried out during the 1920s and 1930s were asking the same questions that are still being asked today: What areas of a child's life are affected by a program of acceleration? Does acceleration affect a student's academic achievement, concept of self, extracurricular activities, or social adjustment? Are effects in these areas positive or negative? (Colangelo et al.)

"Acceleration is described by Pressey (1949) as 'progress through an education program at rates faster or at ages younger than conventional' (p. 2). According to that definition, Southern, Jones, and Stanley (1993) identified 17 educational types of accelerative options" (Colangelo et al.). Some of those options are early admission to school (at various levels), grade-skipping, curriculum compacting, mentoring, subject-matter acceleration/partial acceleration, dual enrollment, Advanced Placement (AP), and early graduation.

Background

Gross (1999) asserted that there is "more than three quarters of a century of accumulated research on the academic and psychosocial benefits of accelerated progression for gifted and talented students." Gross said, "although the academic

acceleration of gifted and talented students is probably the most comprehensively studied and evaluated of all educational interventions, many teachers are reluctant to accelerate gifted students for fear they will suffer social or emotional damage." (p. 1).

Meta-Analyses

The publication, *A Nation Deceived: How Schools Hold Back America's Brightest Students*, (Colangelo et al.) contains an annotated bibliography on acceleration that is current through 2004. This bibliography contains 263 references organized into 12 categories. The report consistently and extensively supports the claims that the academic achievement effects of acceleration are well documented and that the social and emotional effects are less so. In their meta-analyses of the achievement effects of acceleration, Kulik and Kulik (1984), Rogers (1991), and Kent (1992) included 26 studies that were controlled studies with quantitative data (Colangelo et al.).

> The meta-analytic results show that bright students almost always benefit from accelerated programs of instruction. Two major findings support this conclusion. First on achievement tests, bright accelerated youngsters usually perform like their bright, older non-accelerated classmates. Second, the accelerated youngsters usually score almost one grade-level higher on achievement tests than bright, same-age, non-accelerated students do. . . . In contrast to the meta-analytic findings on academic achievement, findings on emotional and social effects of acceleration are fragmentary. Nonetheless, a few conclusions can be drawn. It is clear, for example, that being in an accelerated program can affect a student's long-range educational plans . . . [that accelerated] students aspire to advanced educational degrees, . . . [that acceleration has] no effect on a student's participation in school activities, does not deprive youngsters of the opportunity to participate fully in the life of their schools. . . . It is hard to make sense of the meta-analytic results on student feelings about their schools and school subjects (Colangelo et al., pp. 20-21).

In 1993, James Kulik reported that two major sets of meta-analyses of research findings on grouping had been completed. One was carried out at the University of Michigan (Kulik & Kulik, 1991) and the other was carried out at Johns Hopkins

University (Slavin, 1990). These meta-analyses together examined findings from five kinds of grouping programs, including accelerated classes. Kulik reported that the findings from the two analyses were in agreement, but the research teams differed in their overall conclusions. Slavin's (1990) review concluded with findings that ability grouping had no effect on student achievement. This conclusion was applied whether the ability grouping was configured in different forms, carried out as between-class ability grouping, or ability grouping by subject (except in social studies). He concluded that this finding of zero effects of grouping for all ability levels contradicted earlier conclusions that demonstrated benefits of ability grouping for high-level students and detriments for low-level students, and that policy decisions about ability grouping must be based on some other criteria than an expected effect on academic achievement.

However, Kulik (1993) argued,

> The difference in conclusions seems to stem from differences in the scope of the Michigan and Hopkins analyses. The Michigan analysts concluded that the strongest benefits from grouping were found in programs in which there was a great deal of adjustment of curriculum for highly talented learners. The Hopkins meta-analyses did not find any strong positive effects of groups, but they also did not examine grouping programs designed for highly talented students.
>
> A careful re-analysis of findings from all the studies included in the two sets of meta-analyses confirmed that high aptitude students usually benefit academically from ability grouping. . . . Benefits are larger in special classes for higher aptitude learners. Gains on standardized tests are especially large when the programs entail acceleration of instruction.
>
> Evidence was less clear on the noncognitive outcomes of grouping programs. One conclusion is that grouping programs usually have only small effects on student self-esteem. The programs certainly do not lead talented students to become self-satisfied and smug, nor do they cause a precipitous drop in the self-esteem of lower aptitude students. (pp. 2-3)

It is clear that the research and writings among the gifted education community find and hold that the academic benefits of acceleration are established and the evidence for non-cognitive or non-academic effects is less clear. These meta-analyses about the benefits

contrast not only with Slavin, but with earlier findings and conclusions from researchers such as Oakes (1985) and Elkind (1987). Ability grouping, or the practice of placing students in classes that are leveled as high, average, and low and providing instruction at those predetermined levels for years of schooling is referred to as "tracking." Oakes concluded that tracking denies all students the right and access to study a common curriculum, that students who are not in the top track fall behind and suffer from loss of self-esteem. Kulik, J. (1993) contrasted recent and widespread research on grouping with Oakes's (1985) assertions by stating, "Oakes's conclusions, however, are based on her own selective and idiosyncratic review of older summaries of the literature and on her uncontrolled classroom observations" (p. 3). I believe that Oakes equated acceleration of some students with denial of appropriately challenging curriculum and learning experiences for the remaining students. Years after Oakes's challenges to tracking, the results from the Third International Math and Science Study (TIMSS, 1999) shed light on the United States' under-achieving mathematics curriculum and indeed give cause to question whether what we currently refer to as acceleration is indeed what all students should be doing. Elkind (2001) raised the alarm about the dangers of pushing students to achieve and perform at higher levels than they might be ready for in *The Hurried Child: Growing Up Too Fast Too Soon*. W. Thomas Southern (interview, Center for Talent Development, n.d.) called Elkind's work an "opinion piece," but perhaps he was referring to Elkind's (1987) essay, "Superkids and Super Problems." Elkind (n.d./1988) clarified his position about acceleration in a presidential address:

> Young people who have been academically accelerated are intellectually challenged, complete high school and college early, and in many cases go on to successful careers. Doesn't this contradict the developmental position that growth can't be accelerated? And, from my own standpoint,

> doesn't this fly in the face of all that I have written about the stressful effects of hurrying?
>
> Not really. In fact, acceleration is really the wrong word here . . . When an intellectually gifted child is promoted one or several grades, what has been accelerated? Surely not the child's level of intellectual development - that, after all, is the reason for his or her promotion! What has been accelerated is the child's progress through the school curriculum. But this can be looked at a different way, not so much as acceleration as *tailoring.* What promotion does for intellectually gifted children is to make a better fit between the child's level of intellectual development and the curriculum. . . . Promotion of intellectually gifted children is another way of attaining the goal we have been arguing for at the early childhood level, namely, developmentally appropriate curriculum. Promotion of intellectually gifted children is simply another way of attempting to match the curriculum to the child's abilities, not to accelerate those abilities…. Indeed, the positive effects of promoting intellectually gifted children provide additional evidence for the benefits of developmentally appropriate curricula.

While it is true, as Gross stated (1999), that there are many studies on acceleration, spanning many years, much of the research has not been published in the past 15 years. For example, in Kulik's meta-analysis, "only a small number of studies investigated social and emotional effects of acceleration" (Colangelo et al., p. 18). Of the 13 studies of social and emotional effects of acceleration mentioned in the 2004 report, *A Nation Deceived* (Colangelo et al.), only one study, conducted by Cornell, Callahan, & Loyd, in 1991, was conducted within the last 20 years. The other 12 had been conducted between 1953 and 1986. Karen Rogers's synthesis of research studies on all forms of acceleration identified 21 research studies. These studies were published between 1962 and 1987. Seventeen of the 21 studies were in mathematics acceleration.

Again, contrasting what is known about the academic effects and the social and emotional effects, Colangelo, et al. summarizes:

> By now, the evidence concerning the positive academic effects of acceleration in all its many forms has been well accepted and, for the most part, academic issues are no longer a serious concern for educators or parents of gifted students. Much more pervasive and subtly entrenched are

> concerns about social and emotional effects (Jackson, Famigelietti, & Robinson, 1982; Southern, Jones, & Fiscus, 1989; Vialle, Ahston, Carlon, & Rankin, 2001). These worries are usually confined to forms of acceleration that involve younger gifted students being placed in settings with older classmates rather than in more advanced classes with other students of their own age. Although the absence of anticipated harmful effects of acceleration on affective development is a redundant finding of research in this field (Nornell, Callahan, Bassin, & Ramsay, 1991), the fears just don't go away. (p. 59)

Longitudinal Studies

Several longitudinal studies of acceleration exist, including Bloom's (1985) landmark study that described the development of well-known mathematicians, artists, athletes and neurologists. He also identified and interviewed 20 research mathematicians who had high achievement in their field by age 35 and, when possible, interviewed their parents. The researchers were looking for a retrospective picture of the development of these very talented people. The findings indicated that these individuals did not show early promise in childhood but began to stand out during adolescence.

For many decades, Julian Stanley made countless contributions to the research regarding acceleration, mathematics and science learning, and teaching gifted and talented students. Stanley's research not only spanned the decades but also spanned the research field with various approaches, methodologies, and designs. His research included case studies, experimental designs, surveys, and longitudinal studies. His longitudinal studies concerned students who entered Johns Hopkins University two or more years ahead of their age group and those who were very young college graduates. He also established the Study of Mathematically Precocious Youth (SMPY) at Johns Hopkins University, which has become renowned in its longitudinal reach and breadth.

Since it began, several slices of the longitudinal research from the SMPY have been published. The most recent were released in 2000, 2001, and 2004. Each of these

studies examines a specific feature of SMPY. One of the latest studies by Lubinski, Webb, et al., 2001, Journal of Applied Psychology, 86, 718-729) is identified as A 10-Year Longitudinal Study of the Top 1 in 10,000 in mathematical or verbal reasoning (N=320) identified in the early 1980s (at age 13) [SMPY Cohort 3] (in Colangelo et al., p.25). Another study of this data (Benbow, Lubinski, Shea, and Eftekhari-Sanjani, 2000) is A 20-Year Longitudinal Study of the Top 1% (N=1,975) in mathematical reasoning ability (some of whom were more verbally than mathematically precocious), identified throughout the 1970s (at age 13) [SMPY Cohorts 1 & 2] (in Colangelo et al., p. 26). A third study (Bleske-Rechek, Lubinski and Benbow, 2004) was restricted to examining feelings and educational outcomes based on participation in Advanced Placement (AP) versus not participating in AP. A fourth study on the SMPY cohorts by Lubinski, Benbow, Shea, Eftekhari-Sanjani, and Halvorson (2001) focused on a comparison of top male and female math and science graduate students. Lubinsky (in Colangelo et al.) summarized the empirical findings of the four studies.

> Overall, these four studies paint a clear picture. Being responsive to individual differences in learning rates facilitates achievement and learning, and the subjective impressions of intellectually precocious participants who experienced such opportunities view them positively well into adulthood. . . . Intellectually precocious students who experience educational acceleration in middle school and high school view their pre-college educational experiences much more positively than their intellectual peers who were deprived of such experiences. . . . In working with special populations, all interventions – as well as all decisions not to intervene – engender positive and negative effects, yet the evidence reviewed here strongly suggests that the former far outweigh the latter. Having said this, a brief mention of some things that could contribute further refinement to educational acceleration is in order.
>
> First current practices are not identifying certain populations of intellectually precocious youth who would profit from accelerative learning experiences. . . . Second, affective and conative [sic] factors need to be attended to as well. Non-intellectual personal attributes, such as interests, values, and time willing to study and work, are critical for

> effective educational-vocational counseling (Dawis, 1992, 2001; Lubinski & Benbow, 2001), the implementation of accelerative educational opportunities, and the scientific study of the developmental trajectory of intellectual precocity (Achter et al., 1999; Lubinski & Benbow, 2000; Schmidt et al., 1998, Web et al., 2002). These relatively neglected aspects of individuality are important to be vigilant of in research and practice associated with educational acceleration. (p. 34)

Rationale

The existence of acceleration and the discussion of its effects do indeed have a long history. The research of the academic effects of acceleration that has been published in the past five to eight years is overwhelmingly positive. This contrasts with the assertions and research that dominated educational decisions and policies in the 1980s. However, those earlier assertions often equated acceleration of some students as tracking for all students. As is usually the case, research is slow to affect practice. Through the span of years, research, and literature on acceleration, there is consensus that the concerns that schools, teachers and administrators have about the social and emotional effects of acceleration, as well as the concern that acceleration of some is equated with tracking for all, keep schools and districts from pursuing acceleration to meet students' learning needs. Some school districts, including the one in this study, are trying to implement the researched and suggested practices of acceleration as an option for meeting students' developmental learning needs but continue to struggle with the issues. More needs to be known about the social and emotional effects of this educational intervention. Additionally, Renzulli, Reid, and Gubbins (n.d.), report in *Setting an Agenda: Research Priorities for the Gifted and Talented Through the Year 2000* that number one of fifteen recommendations for research priorities concern the "impact of gifted programs on student outcomes (longitudinal)" (p. 16). This includes researching the long-term impact

of programs and examining whether there are effective methods of producing high quality programs and services to students who are not formally identified. (p. 18)

The Problem and Purpose

In 1990, the school district where I was working as a mathematics teacher raised the levels of its mathematics standards, materials, and expectations for all students. By 1992, advanced sixth grade students were studying pre-algebra, which was the lowest level high school course. By 1995, district leadership wondered whether advanced middle school students could successfully study formal high school Algebra I a year earlier than usual. (It was traditionally positioned in the eighth grade for advanced students.) In 1996, I became the mathematics curriculum supervisor in the district and supported a district pilot study in one seventh grade class to examine the question of whether seventh grade students' taking formal Algebra I could be successful. In 1997, acceleration of mathematically promising students beginning in the seventh grade was initiated district-wide.

The school year 2002-2003 was the sixth year that students in this large suburban school district in the southeastern part of the United States had the opportunity to participate in an accelerated mathematics curriculum for mathematically promising students. This type of acceleration is known as "subject-matter acceleration/partial acceleration." This practice allows students to be placed in classes with older peers for a part of the day (or with materials from higher grade placements) in one or more content areas (Colangelo et al.). In this case, the participants experienced both types of settings. During 7th and eighth grades, the students were in classes with their own peer group using materials and curriculum from higher grade courses. Beginning in the ninth grade, they

were placed in classes with older students for mathematics classes. The first cohort of students was the first to experience the entire scope of the program, from the 7th through the 12th-grades. These were the first students to have the opportunity to complete formal Algebra I and Geometry in middle school, opening the door to more and higher levels of mathematics courses in high school. This study involved open-ended surveys and in-depth, unstructured interviews to gain understanding of the lived experiences of the students with the hopes that their stories and reflections would reveal insights into their social, emotional, and affective experiences with acceleration.

Guiding Research Questions

Through open-ended, unstructured, in-depth interviews, I proposed to study the following questions:

1. What do students tell about their mathematics learning experiences over their middle and high school years in an accelerated learning program?
2. Do these students report themselves as successful or satisfied, or unsuccessful or dissatisfied in their mathematics learning experiences? What measures do they use to describe their success, lack of success, satisfaction or dissatisfaction? To what do they attribute their levels of success and satisfaction?

Significance

Why did I believe in the possibility of success with the decision to accelerate some students into higher level mathematics classes at an earlier age? The National Council of Teachers of Mathematics (NCTM) with its 1989 publication of *Curriculum and Evaluation Standards for School Mathematics* promoted the teaching of algebraic thinking beginning in the primary grades. Numerous articles had appeared in NCTM

journals regarding the importance of learning algebra, and the importance of giving all students access to the opportunity to learn algebra. Robert Moses (2001) referred to Algebra as the new "civil right" (pp. 3-22). NCTM had published a teacher-training package called "Algebra for Everyone" (1991). As well, NCTM expressed concern about the fact that mathematics-teaching practices in the United States continue to hold the majority of our students in a long, arduous study of arithmetic through the eighth grade. This was confirmed with the findings of the Third International Mathematics and Science Study (TIMSS, 1999).

The TIMSS (1999) found that the expectations and challenges in mathematics classes for students in the United States are lower than those found in most other countries that participated in the study. Forty-one countries participated in the eighth grade portion of the study. Authors of the study found that "topics taught in [eighth grade] U.S. mathematics classrooms were at a seventh-grade level in comparison to other countries, while the topics observed in German and Japanese classrooms were at a high eighth-grade or even ninth-grade level" (p. 54). This report also stated, "The content of [eighth grade] U.S. mathematics classes requires less high-level mathematical thought than classes in Germany and Japan" (p. 2). The TIMSS analysis showed that students around the world were learning more and deeper mathematics at younger ages than students were in the United States. TIMSS results also increased awareness that perhaps even the United States' top-performing students were not reaching as high achievement levels as might be possible for them. Armed with this information, I felt confident that the youngsters could learn and understand the mathematics. What I wanted to know was whether they would like the experience or not.

I felt morally and ethically compelled to gather data on the students as they progressed through this experience so that the benefits, pleasures, difficulties and challenges could be known and understood. Because my own "knowledge claim" is social constructivism, which implies that meaning is varied and multiple, use of surveys and follow-up, in-depth interviews provided the best vehicles to collect and understand the participants' various views of the experience. I expected that students would describe some difficulties and challenges and that they would ultimately describe the experience as a necessary and positive one.

This work contributes to the body of knowledge surrounding the mathematics education of mathematically promising students by providing additional insight into the social and emotional effects of acceleration and the experiences of students who participated in acceleration of their mathematics learning. This research has the potential to serve students and parents by giving them information about the range of possible experiences associated with participation in such programs and thereby inform their choices and decisions. This research also contributes to the body of knowledge surrounding the effects of and reactions to raising mathematics achievement expectations for these students, who are a subset of the broader population. In turn, this should raise questions to be explored about raising mathematics learning expectations for all students in the broader population, an idea that is gaining momentum nationwide through No Child Left Behind legislation.

CHAPTER 2

METHODOLOGY

Theoretical Orientations

Determining the theoretical orientations of my research required much reflection and analysis. It also proved to be difficult. During an introspective journey for theory, I was able to rule out some theories and orientations, even though they contained some aspects of my perspective. Although I intended to examine some key features of feminism, emotion and feeling, I was not looking at gender or power issues (Bogdan & Biklen, 1998) Although some would accept and even assert, e.g., Howley, Howley, & Pendarvis, (1995) that gifted and talented students are marginalized by society, (school) structure, and social inequality, trying to make that particular case was not what I intended. So I ruled out critical theory. While I consider myself a constructivist, this study was not about what knowledge the students had gained and made meaning of from their mathematics classes.

This study was to be about what this experience was like for these students. There were many aspects of it that I was curious about. I realized that the many questions I was interested in came from many perspectives and perhaps this was the source of my struggle with a theoretical framework

To elaborate, some questions were phenomenological in nature. They included, "What was it like to live this experience?" "What were they feeling and thinking?" "Did they think they learned what they needed to?" "Did they feel successful or satisfied and

by what definition?" "What do they think contributed to their satisfaction or dissatisfaction?" Other questions were evaluative: "Should the district continue this program?" "Why?" Still other questions could be answered with survey data: "What grades did they make in their courses?" "What courses did they take?"

One alternative was to declare that there was no theoretical framework. In the beginning stages, I could find no overwhelmingly clear mandate about which theoretical or conceptual framework to lay over this research. I thought I would take comfort in Bogdan and Biklen's (1998) idea that it would emerge.

> As a qualitative researcher planning to develop some kind of theory about what you have been studying, the direction you will travel comes after you have been collecting the data, after you have spent time with your subjects. You are not putting together a puzzle whose picture you already know. You are constructing a picture that takes shape as you collect and examine the parts. (Bogdan & Biklen, pp. 6-7)

Another alternative to deal with the competition for theoretical frameworks was to limit my interests and potential follow-up questions. However, I knew that I would have limited access to the participants and there were so many ways that only they could provide information and the perspectives of participants. It seemed shortsighted and self-serving to limit the interviews to asking only follow-up questions that fit a particular theoretical framework so that I might have an easier time processing the results. Deciding to limit the possible paths that the discussions might take would amount to limiting and defining the experience by my terms rather than listening carefully to their descriptions and going down the paths that the participants wanted to take. Thus, I made a conscious decision to mine these students' experiences for everything I could learn and everything they were willing to share. Searching deeply for what was most important to me about the research, with the knowledge that there was limited information and lots of concern about

the social, emotional, non-cognitive aspects of acceleration, I decided that these aspects might be best viewed and understood by examining their experiences. This was paramount. I was most keenly interested in the students' personal accounts of their experiences. I believed that these personal accounts would help me understand what this experience was like for them, how they felt about it and how they interpreted these experiences in their lives, both in the past and for the future. I decided not to limit the possible questions that might arise and that did not fit nicely in a framework best suited for examining experiences but rather to see if the participants' stories might inform those questions in some way. I reasoned that their stories might shed light on the evaluative and numeric data types of questions, if not answer them. Still, some rules of engagement were needed to frame the problem and guide the process, and a lens was needed for viewing and analyzing the results. Key among the aspects of my theoretical orientations was phenomenology.

Phenomenology

Bogdan and Biklen (1998) maintained that most qualitative researchers are concerned with phenomenological perspectives. "While there are theoretical differences between qualitative approaches and even within single schools (Gubrium, 1988; Meltzer, Petras & Reynolds, 1975), most qualitative researchers reflect some sort of phenomenological perspective" (p. 23). Phenomenology resists an easy, compact definition as it has many variations in its parameters and structures. It is both a particular research method, and it is more generally situated in qualitative research as a mode or orientation (Bogdan & Biklen).

The roots of phenomenology can be traced back to Edmund Husserl. He introduced the term in 1913. Sartre, Merleau-Ponty, and Heidegger were also key figures in the early days of phenomenology. For Husserl, who is sometimes referred to as the founder of phenomenology, it was a philosophy and the search or distillation of the "essence" of being, feeling, understanding, and meaning. He saw it as "the study of structures of consciousness that enable consciousness to refer to objects outside itself. This study requires reflection on the content of the mind to the exclusion of everything else" (Phenomenology, p.1). This was called phenomenological reduction, and in order to accomplish this, one could not "presuppose that anything exists, but rather amounts to 'bracketing of existence,' that is, setting aside the question of the real existence of the contemplated object" (Phenomenology, p.1). In addition to bracketing, he also established the principles of epoch and reduction, which are ways that a phenomenological researcher should suspend his or her own notions and assumptions about reality in order to listen and understand ordinary phenomena, things and happenings. He described transcendental phenomenology as the study of basic components of the meanings that make intentionality, the ability to direct an act "toward an object under a certain aspect," possible. Van Manen (1990) explained it like this:

> From a phenomenological point of view, to do research is always to question the way we experience the world, to want to know the world in which we live as human beings. And since to *know* the world is profoundly to *be* in the world in a certain way, the act of researching-questioning-theorizing is the intentional act of attaching ourselves to the world, to become more fully part of it, or better, to *become* the world. Phenomenology calls this inseparable connection to the world the principle of "intentionality." (p. 5)

Heidegger was both a colleague and critic of Husserl, and he claimed that phenomenology "should make manifest what is hidden in ordinary, everyday experience"

(Phenomenology, p.1). In 1927, he described "the structure of everydayness, or being-in-the world, which he found to be an interconnected system of equipment, social roles, and purposes" (Phenomenology, p. 1). Sartre, Merleau-Ponty, and Heidegger were all existentialist phenomenologists in that they denied that it was possible to "bracket" existence.

More recently, Van Manen (1990) offered eight descriptors of phenomenology:

1. Phenomenological research is the study of lived experience. . . . It differs from almost every other science in that it attempts to gain insightful descriptions of the way we experience the world pre-reflectively, without taxonomizing, classifying, or abstracting it. So phenomenology does not offer us the possibility of effective theory with which we can now explain and/or control the world, but rather it offers us the possibility of plausible insights that bring us in more direct contact with the world. (p. 9)
2. Phenomenological research is the explication of phenomena as they present themselves to consciousness. To be conscious is to be aware, in some sense, of some aspect of the world. And thus phenomenology is keenly interested in the significant world of the human being. . . . A person cannot reflect on lived experience while living through the experience. . . . Thus, phenomenological reflection is not *introspective* but *retrospective.* Reflection on lived experience is always recollective; it is reflection on experience that is already passed or lived through. (pp. 9-10)
3. Phenomenological research is the study of essences. Phenomenology asks for the very nature of a phenomenon. For that which makes a some-'thing' what it *is* –and without which it could not be what it is (Husserl, 1982; Merleau-Ponty, 1962). . . . The essence or nature of an experience has been adequately described in language if the description reawakens or shows us the lived quality and significance of the experience in a fuller or deeper manner. (p. 10)
4. Phenomenological research is the description of the experiential meanings we live as we live them. Phenomenological human science is the study of lived or existential meanings; it attempts to describe and interpret these meanings to a certain degree of depth and richness. (p. 11)
5. Phenomenological research is the human scientific study of phenomena. . . . Phenomenology claims to be scientific in a broad sense, since it is a systematic, explicit, self-critical, and intersubjective study of its subject matter, our lived experience. It

> is *systematic* in that it uses specially practiced modes of questioning, reflecting, focusing, intuititing, etc. Phenomenological human science research is *explicit* in that it attempts to articulate, through the content and form of text, the structures of meaning embedded in lived experience . . . is *self-critical* in the sense that it continually examines its own goals and methods in an attempt to come to terms with the strengths and shortcomings of its approach and achievements. It is *intersubjective* in that the human science researcher needs the other . . . to develop a dialogic relation with the phenomenon. (p. 11)
>
> 6. Phenomenological research is the attentive practice of thoughtfulness. . . . In the works of the great phenomenologists, thoughtfulness is described as a minding, a heeding, a caring attunement (Heidegger, 1962) – a heedful, mindful wondering about the project of life, of living, of what it means to live a life. . . . As educators we must act responsibly and responsively in all our relations with children, with youth, or with those to whom we stand in a pedagogical relationship. So for us the theoretical practice of phenomenological research stands in the service of the mundane practice of pedagogy: it is a ministering of thoughtfulness. (p. 12)
> 7. Phenomenological research is a search for what it means to be human . . . As we research the possible meaning structures of our lived experience, we come to a fuller grasp of what it means to be in the world as a man, a woman, a child, taking into account the sociocultural and the historical traditions that have given meaning to our ways of being in the world. (p. 12)
> 8. Phenomenological research is a poetizing activity. . . . Most research we meet in education is of the type whereby results can be severed from the means by which the results are obtained. Phenomenological research is unlike other research in that the link with results cannot be broken, as Marcel (1950) explained, without loss of all reality to the results . . . when you listen to a presentation of a phenomenological nature, you will listen in vain for the punch-line, the latest information of the big news. As in poetry, it is inappropriate to ask for a conclusion or a summary of a phenomenological study . . . the poem itself is the result. . . . So phenomenology, not unlike poetry, is a poetizing project; it tries an incantive, evocative speaking, a primal telling, wherein we aim to involve the voice in an original singing of the world (Merleau-Ponty, 1973). (p. 13)

One feature of phenomenology is that it is used to distill the essence of an experience. I intended to capture some of the range of experiences that are possible from participating in an accelerated mathematics program such as this. So while this study was

not intended to distill or determine the essence of what it means to be a student in an accelerated program of mathematics study but rather to hear and to understand the range of those experiences, it fit every other aspect that I know about phenomenology.

Supporting the phenomenological orientation to the research is my disposition to an interpretive approach for analyzing and making sense of the world. Merriam (2001) described the view of education from the interpretive approach as considering education

> to be a process and school is a lived experience. Understanding the meaning of the process or experience constitutes the knowledge to be gained from an inductive, hypothesis—or theory-generating (rather than a deductive or testing) mode of inquiry. Multiple realities are constructed socially by individuals. (p. 4)

As well, I believe that meaning is constructed by the learner or person who is experiencing the learning or events. While I believe that this pertains to learning and gaining knowledge, I also believe it is often difficult to sort the meaning from knowledge from the meaning of beliefs, perceptions, and experiences.

Social Constructivism

The decisions concerning theoretical orientations also involved explaining my beliefs about how things are known or understood. My "knowledge claim" is social constructivism. This implies that meaning is varied and multiple. According to Creswell (2003), this perspective can lead the researcher "to look for the complexity of views rather than narrowing meanings into a few categories or ideas. The goal of [this] research, then, is to rely as much as possible on the participants' views of the situation being studied" (p. 8). Whether my perspective is a perfect fit to the research or whether I designed the research as I did because this is my perspective is hard to distinguish, but nonetheless, it is a match.

Qualitative Strategies of Inquiry

According to Creswell (1998), a qualitative approach could be the best choice when the research question is descriptive in nature, asking ”how” or “what” rather than “why.” It is also useful when a variable cannot be easily identified or theories are not available or there is a need for a detailed view of the topic. Creswell (2003) suggested that the following criteria for selecting an approach be considered: (a) Is there a match between the problem and the approach? (b) What are the personal experiences of the researcher? (c) Who is the audience?

Regarding the match between problem and approach, Creswell (2003) wrote,

> if a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach. Qualitative research is exploratory and useful when the research does not know the important variables to examine. (p. 22)

My interests and questions about students who experienced a phenomenon, an accelerated program of mathematics instruction, were a match to the qualitative approach with the emphasis on understanding experience and phenomena and a desire for a descriptive and detailed view of the phenomena. As well, the research questions of this study were exploratory in nature.

Creswell’s suggestion that the researcher consider her own background, training and experiences also led me to the qualitative approach, which is characterized by a literary form of writing, text analysis, and use of open-ended interviews and observations. I felt comfortable and adept at using these tools. Finally, the mathematics education community is receptive to qualitative research.

> In describing “Some Shifts in Emphasis in Educational Research in Mathematics and Science,” Kelly and Lesh (2000, p. 37, table 2.1) noted, among other shifts, less emphasis on “researcher remoteness or stances of ‘objectivity,’” and more emphasis on “researcher engagement, participant-

> observer roles"; less emphasis on researcher as expert: the judge of the effectiveness of knowledge transmission using prescript measures," and more emphasis on "researcher as coconstructor of knowledge: a learner – listener who values the perspective of the research subject, who practices self-reflexivity"; less emphasis on "simple cause-and-effect or correlational models, " and more emphasis on "complexity theory; systems thinking; organic and evolutionary models of learning and system change." Underlying these trends is the general understanding that research must be characterized by a diversity of methodologies. (in English, 2002, p. 373)

This research is descriptive, exploratory and qualitative. My orientation to qualitative research is interpretive, constructivist, and phenomenological. The qualitative research paradigm of phenomenology dominates the methods of data collection and analysis of the study.

Researcher as Research Instrument

In qualitative research, the researcher is the primary research instrument. As such, mistakes and misjudgments can be made; biases can filter through and taint the work. Patton (2002) pointed out that neutrality is not an easily attainable stance and that because the investigator is the instrument for data collection, he or she must carefully reflect on, deal with, and report potential sources of bias and error. I must make the reader aware of my background, experiences, and relationship to this research so that any and all lenses and biases through which this research was conducted are apparent.

In the late 1980s, I was a middle school mathematics teacher with slightly more than 10 years teaching experience. I was a newly minted single mom of a two- year old, highly motivated to be the best mom and best, most valuable educator and employee that I could be. I was committed to making myself valuable through professional and personal improvement. I invested in my own professional learning; joined the National Council of Teachers of Mathematics, enrolled in graduate school, learned about and used

cooperative learning groups, conducted grade-level action research, participated in curriculum revision and textbook adoption, attended national and international mathematics conferences, participated as a subject in a research project on reflective mathematics teaching, and designed and delivered mathematics professional development for practicing teachers. In short, if something needed to be learned or initiative needed to be taken that I thought would make me a knowledgeable and valuable employee, I did it.

The district leadership in mathematics was working hard during those years to actualize the new vision and expectations for mathematics learning. I was a classroom teacher then but part of core leadership group envisioning and attempting to actualize this change. We threw out the old versions of expectations, old ideas, old tests, and old tracking folders. We had long arduous discussions and debates about what it meant to understand, know, and use mathematics. We raised expectations and adopted textbooks that caused most teachers in the district to lament, "The students can't do this! They are not prepared and lack prerequisite knowledge." What we had previously viewed as high expectations and mastery of mathematics, 24-36 computation problems concerning a specific area of arithmetic, such as reducing fractions to simplest terms or correctly dividing decimals, did not even come close to the new vision and expectations for mathematics learning during the late 1980s. What we had previously considered as demanding mathematics and evidence of its achievement was, in retrospect, low-level and trivial. But these were the measures that students, their parents, and their teachers had been accustomed to using to gauge their mathematical understanding and ability. This had been the norm for years. The students who were making As in respect to those requirements were making As about many things that were coming to be viewed as

insignificant, shallow, and trivial. Did making As on these types of things really define a gifted, talented, or mathematically promising student? In the every day world of mathematics, students were going to need to do more, understand more, communicate more, and apply more (NCTM, 1989). The late 1980s were times of serious change in K−12 mathematics education across the nation and in my world.

The first set of standards defining the expectations for learning in any content area was in draft form in 1987, being created by the NCTM (1989). NCTM's *Curriculum and Evaluation Standards for School Mathematics (Standards)* provided a whole new vision of what it meant to learn and know mathematics and we, mathematics teachers and supervisors throughout the nation, state, and district, were making some progress, but it was slow, unsystematic and difficult. What was proposed with these *Standards* was profoundly different from that most of us in the field of teaching mathematics to students in schools were used to. High expectations, equity, access, connections, reasoning, sense-making, representing, and understanding concepts were among all the new ideas being proposed (NCTM, 1989). In fact, it was distinctly different from what most of us had experienced going through school ourselves in our preparation to become teachers and in our current teaching practices. I began to look for ways to support teachers in these changes, hoping to help us all navigate uncharted waters. My work with curriculum revision, textbook adoption, reflective teaching, mentoring, and coaching and graduate studies in curriculum, leadership and staff/ professional development became ever more focused and intense.

Our state's mathematics curriculum and achievement were not stellar during this time. Achievement ranked around the upper edge of the bottom quartile of the national

pack, around 36th in the nation. Our state curriculum was built on the prevailing ideas of the times, a spiral curriculum in which students would start small and get bigger and more flavorful tastes of mathematical topics each consecutive year, supposedly going deeper each year. The few teachers I met who risked having an opinion thought the "required by law" state curriculum was just a big collection of topics and that no matter what grade you taught, there were too many of them and students never seemed to remember anything from year to year. Many years later, when state mathematics achievement sunk to the bottom of the nation, an outside audit of the curriculum was ordered. We learned, after an independent audit of the curriculum by Phi Delta Kappa (PDK), that it was indeed shallow, repetitious, fragmented, disjointed, "too much," and that it promoted fragmented, disjointed, shallow teaching. It was determined that it would take about 22 years of instruction to deliver the "required by law" state objectives in the K−12 mathematics curriculum. Again, because it was required by law to deliver the state curriculum, most districts in the state built their local curriculum directly upon it. Our district was no different, except that we generally operated from the idea that the state curriculum must be minimal, so ours would be all that and more!

The district I worked in was a large and largely affluent, suburban county in the southeastern United States where adults generally valued education. Most of the newcomers to the region were college-educated professionals. They valued a good education. Many of them were people who might have been motivated to enroll their children in private schools and could have easily afforded to do so, but they did not. They did not because the district had a reputation for excellent, high achieving schools and there was no point in spending extra money for an outstanding education when it was

already being provided. These parents frequently participated as active, concerned, and vocal partners in their children's education. Most had high expectations for the education of their children and high expectations for their children's achievement, and they knew how to access the system to communicate with it. The students in many of the schools were competitive with each other about their grades and class standing, their parents were competitive about academic achievement and standing, teachers within schools were competitive and schools within the district were competitive. It would not be uncommon in some schools in this district for sixth grade students and their parents to express openly worry about the student's future status as valedictorian. It is in this environment that the mathematics leadership in this district began to raise the expectations and the quality of the mathematics program in the public school system.

One problem with raising standards and expectations at any time is that when students are not accustomed to doing more, thinking more deeply, or challenging themselves in meaningful ways and they are accustomed to making good or high grades from minimal effort, they may resent the change in the game. The many students who had mastered the state curriculum through about 5th or sixth grade, had indeed usually mastered arithmetic, and they and their parents were right to insist that the students did not need another three years of arithmetic. They were ready for something more rigorous and interesting but they had been raised on high grades for low-level expectations and low-level curriculum. How would this play out? Could teachers be asked to expect more of their students and therefore more of themselves? Would the students rise to the challenge? Would their parents accept that more and deeper learning might not translate to automatic, expected high grades? Would parents accept that learning more challenging

mathematics would, in the long run, be more beneficial than a highly inflated grade surrounding shallow expectations? What could and would be done to help and support teachers, those who both did and did not believe this was possible or necessary?

In 1990 the district raised the levels of its mathematics standards, materials, and expectations for all students. By 1992 advanced sixth graders were studying Pre-Algebra (the lowest level high school course) and by 1995 district leadership was wondering whether advanced middle school students could successfully study formal high school Algebra I a year earlier than usual, which was traditionally positioned in the eighth grade for advanced students.

In 1996 I became a mathematics curriculum coordinator in this school district; where, like Lake Wobegon, all the children are above average, especially in mathematics. In fact, many were, but as I mentioned earlier, generally not for the reasons that they, their parents, or their teachers thought. Given the district leadership's interest in whether advanced middle school students could successfully study formal high school Algebra I a year earlier than usual, a pilot study was undertaken in one seventh grade class in 1 of 14 middle schools in the district to teach the formal high school Algebra I curriculum to the 30 best mathematics students entering the seventh grade. It was to be taught in a manner that was considered appropriate for middle grade learners. The sixth grade mathematics teachers in the school were asked to recommend the best and strongest mathematics students that were leaving their classes at the end of sixth grade. There were no qualifiers in place. Rather, the teachers each recommended their strongest and most talented students by any measure they chose. When the

names were assembled, there were only about 24 students. In an effort to fill the class to capacity and balance the class load that other teachers would have during that class period, more recommendations were requested. After the names were compiled, data was then assembled about each student that included the student's final course grade attained in the sixth grade Pre-Algebra class, standardized achievement test scores in mathematics, and cognitive ability test scores. From these data, a profile of this type of student was created. The criteria are outlined in Table 1. It should be noted that the criteria did not require that these students were previously identified and labeled as gifted and talented.

Their teacher proceeded to teach the formal high school Algebra I curriculum to these students in a manner that was considered appropriate for middle grades learners; that is, interactive, hands-on, collaborative, engaging and sensibly paced. These students were administered the same end-of-course examination in algebra that was given to the older students who were also taking Algebra I, in both 8th and ninth grades. They all passed it. Then came the question of whether and how to make this opportunity available for all youngsters throughout the district.

Meanwhile, during the year of the pilot study, I held regular monthly meetings of the mathematics lead teachers from each of the district's middle schools. The discussions often turned and returned to "What are we going to do about the very bright seventh graders in our schools who have already mastered our Pre-Algebra course in sixth grade? They seem to be in a holding pattern during seventh grade while they wait to take Algebra in eighth grade. We seem to be putting them to sleep with the bridge course we

Table 1

Criteria for Participation in seventh grade Algebra I Program

1	8th stanine on Quantitative section of Cognitive Ability Test
2	9th stanine on Math Composite section of the Iowa Test of Basic Skills
	OR the REVERSE OF 1 and 2 above
3	Completion of sixth grade Pre-Algebra course with 92% cumulative average
4	Student desire and commitment to participate

are offering, Beginning Algebra and Geometry. We are not giving them enough. We are not challenging them." The students were in fact being held in a bridge course while they waited to become eighth graders and could take Algebra I. Students taking Algebra I in the eighth grade were already considered advanced. The teachers said that the advanced seventh grade students were bored, unmotivated, and unchallenged.

I knew that there was a great deal of controversy about the idea of accelerating students. From outside sources, I was aware of the concerns about democratic access to mathematics learning experiences raised by Jeannie Oakes and Walter Secada. Inside the district many teachers believed that these students should be grown horizontally (given more experiences with their current knowledge and learning) rather than vertically (accelerated into advanced math courses). Each and every month this issue was discussed. What I believed very deeply was that, whether students needed to be accelerated or not, the beliefs of the teachers who would teach them would determine the quality of the experience the students would have. Therefore, I waited for nearly a year,

asking the teachers each time for their solution to the problem they raised regarding the typically bored and apathetic, advanced seventh grade student.

Based on the discussions, debates, and the pilot study, the solution the teachers finally proposed was to offer formal Algebra I a year earlier to a small, selective group of mathematically promising students. For all students who met the criteria and indicated a desire, high school Algebra I was offered in seventh grade. The domino effect of this was that they would then take Geometry as eighth graders, Algebra II as ninth graders, Advanced Algebra/Trigonometry or Analysis as 10th-graders, Calculus as 11th-graders and Statistics or a post-secondary option math class as 12th-graders.

The differences in the hyper-accelerated mathematics program, as this came to be called, and the advanced program, previously the most advanced track of courses in the school system, are outlined in Table 2.

Additional criteria surrounding this situation were that the teachers who were to teach Algebra I for high school credit to seventh graders had to be qualified. Their transcripts underwent analysis to determine whether the teachers had a minimum of four college math courses, as would be required if they were teaching in a high school setting. Once the minimum number of courses was established, they were required by the district to take a 50-hour staff development course on teaching Algebra I to this special type of student: young, mathematically promising, inquisitive, probably immature and precocious. I was the provider of this training.

It was clear in reviewing the changes in the progression of courses and the grade levels they were delivered in that this action required approval and acceptance from all groups and levels of teachers because the domino effect of this action would have

Table 2

Comparison of Course Placement in Advanced Program and Hyper-Accelerated Program

Grade Level	Advanced Program	Hyper-Accelerated Program
6th	Pre-Algebra	Pre-Algebra
7th	Beginning Algebra and Geometry	Algebra I
8th	Algebra I	Geometry
9th	Geometry	Algebra II
10th	Algebra II	Advanced Algebra/Trigonometry or Analysis
11th	Advanced Algebra/Trigonometry or Analysis	AP Calculus
12th	AP Calculus	AP Statistics or Multivariate Calculus or other college-level mathematics course

repercussions that would reach far beyond the students and teachers in seventh grade. The implementation of this program of study called for planning what these students would study in eighth grade and on through high school. It would require the teachers of all the grades to engage in dialogue and true vertical teaming, talking to the grade-level teachers both above and below their own grades. It would require all teachers to learn how to teach the exceptionally promising and the exceptionally young mathematics student and to expect more from their students and from themselves.

One might wonder how well the students actually learned mathematics as measured by their achievement and test scores. Test scores from the school district indicate that this group of students out-scored all other groups on the Algebra end-of-

course examination in their first year of the program, when they completed Algebra I as seventh graders (Whitlow, 1998). This comparison included the district's eighth grade Algebra I students and the district's high school Algebra I students. As a group, these students made the best grades in the district and proved that though a year younger than their peers, they were capable of mastering the advanced content of formal high school Algebra as seventh grade students. Other data has been examined to determine changes in teachers' beliefs and attitudes after they worked with these mathematically promising students (Whitlow).

An additional bias that I had was related to the behavior that I had experienced with this type student as I had taught them over the years. Although I was very concerned about the need to develop and deepen the intellectual capacity of this type of student, I did not always enjoy what I perceived as an attitude of intellectual superiority that was often displayed by this type of young student. I was not fond of the intolerance and insensitivity that I thought I read in many of their interactions with their peers. While I thought they were quite smart and bright, and I enjoyed stimulating their minds, listening and watching them work and think, sometimes their arrogance was hard to tolerate. As their classroom teacher, I sometimes found myself counseling students to convince them that there were many ways to be talented in life and many important ways to be talented were not centered on intellect. But I had learned from many years of experience to hold my impressions in check and watch what kinds of things actually happen rather than react to things that are said. Besides, they were still very young.

Last, I held strong beliefs about the role of the teachers in the success of the program and the quality of the students' experiences. I always felt that the teachers'

attitudes and beliefs about whether students could and should accelerate their mathematics learning would make or break the success of the project.

Throughout the early stages of this project, in the capacity of my job, I gathered data. I collected the students' scores on the district Algebra I end-of-course examination. I collected a hundred or more surveys from the students at the end of the first year (end of their seventh grade), some from their parents, and many from their teachers. I gave teachers pre- and post- attitudinal surveys about working with these students and looked for changes. I have always been concerned with the welfare of these students and interested in researching the effects of my decisions and leadership on them.

Because I left the district, I always intended to find out what it was like for the students to have this experience. I wondered and worried about those who started on this path and left it. I wondered about the ways that acceleration was the appropriate thing to do for them. I always believed that the students were capable of learning the mathematics presented to them but wondered whether they would still love to learn mathematics as time and experiences (with teachers and older classmates) passed. I always wondered what they would tell us, if given the opportunity, about the ways that this opportunity made them successful and what ways we or other factors were obstacles and detriments to their success. My assumptions were that students would report some difficulties but more benefits.

The Research Design

Participants

This study is situated in a large, suburban, metropolitan school district in the southeastern United States. Some students in this district were identified as

mathematically promising students, based on specific local district criteria, beginning with the 1997-1998 school year. Approximately 300 of the approximately 10,000 seventh grade students in the district were identified and offered an opportunity to enroll in a formal, high school Algebra I class as a seventh grade student. Each of the 14 middle schools in the district had at least one class of students taking Algebra in the seventh grade. The majority of the schools in the southern part of the district, which was characterized by greater diversity, transiency, and greater ranges in socioeconomic status than the other regions, barely had enough students identified to form one class. One school in that region asked for permission to run the program with only 14 identified students, and they were given permission to do so. The majority of the schools located in the other geographic regions of the district easily filled the roster for a class of 30 students and sometimes had more.

In the 2000-2001 school year, this cohort of students was in the 10th-grade. By this time, I was no longer the district mathematics coordinator in the district where this program was in place, as I had taken a similar position in a different district. Regardless, the students would be in their fourth year of accelerated mathematics study by this time, if they were still involved in the program. Even if they were not still in the program, they were 4 years out from having started in the program. I thought it was time to see how they were doing. I consulted with the district mathematics coordinator who had assumed my previous position, and we agreed that the district would be interested in knowing how the students in or out of the program were doing. She indicated that the district leaders were in conversation about the merits of the program and that information about the students' experiences would be useful. She agreed to let me devise a survey that she

would provide to the students. We brainstormed how the students would receive the survey. If the survey was given to 10th-graders who were taking 11th-grade math courses, those would be the students I was looking for. However, if they had dropped out of this program of study they would not be in the 11th-grade mathematics courses. I wanted to find all the students, whether they were still in the program or not, and I had a particular interest in wanting to know about the experiences of those who left the program. The mathematics coordinator agreed to address the surveys to individually named students, getting those names from the district's rosters of students who took Algebra I in the seventh grade and Geometry in the eighth grade. Those surveys were sent to the counselors in individual high schools that the students were supposed to attend. The counselors ensured that the students received the survey, regardless of the mathematics courses they were or were not taking. Approximately seven surveys were returned to the mathematics coordinator because the students were not enrolled in the school anymore. The rest were delivered to the students. They could voluntarily complete the survey and return it to the mathematics coordinator.

The survey (see Appendix A) asked the students about their grades, the courses they had taken, the courses they intended to take, their satisfaction with each course, their enthusiasm for mathematics, any positive benefits, any negative effects, how strongly they rated their backgrounds in algebra and geometry, and what suggestions for improvement they might offer. The grades they attained in each course were reported as a percent, such as 92, or as a grade of A or B, or other. The satisfaction with the courses was rated on a Likert-like scale, but rather than using wording of "agree/disagree," a semantic differential scale was used. The students were asked to rate their experiences

from 1 (*negative*) to 4 (*positive*), forcing them to choose a positive or negative rating rather than a neutral rating. A semantic differential scale is used to gather a sense of feeling about a topic rather than agreement with a particular statement. Some examples of the scales I used are (a) extremely dislike to extremely enthusiastic, (b) very weak to very strong, and (c) negative to positive.

For each of the courses during the 4 years that had passed since they began, students were also provided an open-ended section for "comments." There were some open-ended questions on the survey as well. They pertained to positive benefits, negative effects, plans for mathematics courses during junior and senior years of high school, and plans following graduation. Students were asked to provide suggestions for improvement to the program. Finally, the students were asked, "Would you be willing to be contacted for an interview?" If the student chose "yes" she or he was asked to provide her or his name, address, phone number *and* her or his parent's signature indicating permission to contact the student. Of the approximately 300 surveys dispersed, 64 or approximately 21% of the students voluntarily returned the survey. This became the first round of data collection. It was centered on creation and distribution of a survey that was intended to find and gain access to the possible pool of participants.

Selection Procedures

The participants for the interviews were selected through purposeful sampling. This strategy involves purposefully selecting participants that are hoped or expected to help the researcher understand the problem or investigate particular cases or circumstances, as opposed to random sampling. Patton (2002) described it as selection based on the case's being "information rich" and illuminative. The sampling is aimed at

gaining insight about the phenomenon, not empirical generalization from a sample to a population. The number of participants in this study was not predetermined. When using in-depth interviews, the number of interviews is generally kept small. Six interviews are considered ample for phenomenological studies. My plan was to let the sample size be determined by the nature of the information provided by each interview, but not to exceed nine. As well, I had planned to terminate the sampling when informational redundancy was achieved (Lincoln & Guba, 1985), if not earlier.

Sixty-four of the surveys were returned, and I used the information in the survey as the starting place for sampling. I reviewed the 64 surveys for three key indicators. First I looked for a range of responses to the question, "How would you rate your enthusiasm and enjoyment of mathematics at this time?" Throughout the 64 surveys, responses were recorded for the entire range of 1 (*extremely dislike*) to 4 (*extremely enthusiastic*). While I was not pleased as the former mathematics coordinator to see the rating of "extremely dislike", I was pleased as the researcher that I had connected with students with a broad range of experiences and outlooks about the program. Two of the 64 surveys were not readable and were subsequently not included.

The second thing I looked for on the survey was whether the student and his or her parent had given permission for the student to be contacted for an interview. Only 30 of those students provided their names, contact information, and parental permission to be contacted for an interview. So, sadly, I was not able to contact the student who rated his or her enthusiasm for mathematics as 1 (*extremely dislike*) and added the comment, "MATH IS THE DEVIL." He or she did not give permission to be contacted for an interview. Only 2 of the 62 student surveys rated this item as 1, and neither student gave

permission to be contacted. Another student's survey was completed by the student's mother, and the enjoyment of math was rated as both 1 (*extremely dislike*) and 2 (*dislike*). She did give permission to be contacted for an interview. I attempted to reach them by telephone, but I was unable to make contact. This mother wrote on the front of the survey, addressed to the mathematics coordinator, "I made a copy of my son's survey packet so I would have the opportunity to express my feelings as a parent, watching my child go through this program. I would love to share my thoughts with you in person." I would like to have known this student's story.

The third item I reviewed for sampling purposes was the ZIP code of the students who provided permission to be contacted. This review was to avoid over-sampling from any one particular school or geographic area in the district and sample as broadly across the schools in the district as possible.

With a range of enthusiasm for mathematics ratings between 2 (*dislike*) and 4 (*extremely enthusiastic*), names, student and parent permissions, addresses, ZIP codes, and phone numbers, I began calling students during the spring of their senior year in high school. The survey had not asked the students to name the high school they attended, so I first began calling one student from each of the seven different zip codes represented. Some of these calls resulted in my leaving a message. After a second attempt, if I did not hear from the student, I called another potential candidate from the same zip code and I reasoned, probably the same school. This caused one situation in which I eventually called a third candidate. I reached the third candidate on the first attempt and she agreed to an interview, but subsequently, one of the students that I previously left a message for called back and also wanted to participate. I did not want to tell her she could not, so

there are two students from the same school who were interviewed. Though from the same school, they had different experiences and even provided corroboration of events mentioned by the other.

Using this method for deciding whom to call, I interviewed the students over the telephone in a cursory manner. I developed and used a protocol for the preliminary telephone interview (see Appendix B). Ultimately I called 14 students, nearly half of the 30 in the pool. Of the 14 students I called, I conducted the preliminary telephone interview with 11 of them. One male student said that he did not want to participate in an in-depth interview. Another student's mother said that the student had "left her home" but said she was sure he would want to talk to me. I was interested in the story he might have to tell, as her comment made me think that he might be an independent thinker. She gave me the number where he was living but after three messages were left, he still had not returned my calls. For 2 of the 14 students I called, I left messages twice with parents but did not receive return calls. I placed four calls to the one student from the southern part of the district who agreed to be contacted, but unfortunately I was never able to reach him.

To summarize, the participants for this study were selected from the 30 students who provided contact information, permission, had enthusiasm ratings from 2 (*dislike*) to 4 (*extremely enthusiastic*). Ultimately, after a preliminary telephone interview, I selected seven students from six different high schools to participate in in-depth interviews about their six years of mathematics learning experience. One student became unreachable after the initial interview and was discontinued in the study. The cases you will read in this study are from six white students whose family socioeconomic statuses ranged from middle to upper class, who attended five different high schools in the same school

district, who all experienced the district's accelerated mathematics learning program between grades 6 and 12.

Confidentiality of Participants

The students who were contacted, including those who ultimately formed the interview sample, were informed that their participation was strictly voluntary and that they could decline to continue participation at any time. They were told that their names, school names, and any identifying information would not be revealed in discussion or in reporting. They were all informed of the intent of the research and that the research process would involve them in an in-person, in-depth, unstructured, audiotape interview and a time for subsequent review of their transcripts. The students were asked for their written consent to participate (see Appendix C). Participants and schools are assigned pseudonyms in this research report. The participants were offered opportunities to review their input in the transcript form of their interview for accuracy, clarity, and intention. All but two confirmed their transcripts through a process called member checking.

Data Collection

These students were not observed working in or interacting with teachers and peers in their classrooms or some naturalistic setting. The data consist of survey responses, telephone interviews, and in-depth interviews. The surveys, completed while the students were in the 10th-grade, captured a snapshot of the students' impressions at a given time, provided descriptive statistical data regarding course-taking patterns and numerical ratings of experiences, and served as an entrée to contact them for a later interview. The in-depth interviews were intended to examine the students' recollections and obtain an overall retrospective of their experiences.

Survey

The first of the data instruments was the survey (see Appendix A). Because it was administered as a sampling strategy, it has been previously discussed in detail in the selection process. Though its primary purpose was to locate participants and determine a pool from which to choose a purposeful sample, it also provided data. Though the reader will find some statistics from the survey in the analysis of this study, the statistics are only descriptive, with a look at trends and tendencies, and then connections to the interviews through frequencies, means, modes, and ranges of the responses. No statistical tests were conducted and no conclusions are drawn from this data. Phenomenological research would not typically place value on the data from a survey, but I used it in the manner that Bogdan and Biklen (1998) described below.

> Quantitative data can have conventional uses in qualitative research. It can suggest trends in a setting and provide descriptive information about the population served by a particular education program. . . . Looking at statistics and comparing them to what subjects verbally report can be helpful in exploring perceptions. . . . Qualitative researchers are interested in how statistics support or contradict subjects' common sense understanding. (pp. 152-153)

Telephone Protocol

Another tool was a telephone protocol (see Appendix B). It was developed to aid further in the selection of participants. It was used to interview prospective participants for the in-person, in-depth interview process. At the conclusion of each phone call where the student seemed like an interesting candidate for the interview conversation, each was offered a dinner or lunch event in conjunction with the interview. Most were at a very busy period of time in their lives, post-graduation, getting ready for trips and summer events related to leaving for college, so most declined the invitation to dine. Though it was apparent that they were all very busy, on the telephone they seemed extremely

interested in making time to talk with me about their mathematics learning experiences. Most frequently each student opted for a location near their homes and schools. In most cases, the interviews were scheduled in their favorite local coffee shop.

In some cases, in setting up the telephone interviews, I had to leave a message for a return call. I recall being surprised that several of the students returned the call as promised. One student even left me a message that he would be out of town for a period of time and would call me back when he returned. He did. Only one student that I spoke to on the telephone did not want to participate in an interview. The rest seemed eager and accommodating. Each one was amiable and set an interview time within the week or month.

Interviews and Audiotapes

A few broad, introductory, open-ended questions were developed to begin the interviews. Most interviews began with a version of "You were a student that took advanced math classes in the seventh grade. I am trying to learn what that experience was like for you during the years. What do you recall about what it was like to learn in your math classes?" Because the research goals of this study were to learn and explore everything possible from the lived experiences of the participants, from what they were willing to share, I wanted engage to them in a comfortable, personal conversation so they could share their narrative, descriptive, and personal accounts of their experiences with me. I relied extensively on these in-depth, unstructured interviews. Each interview lasted at least one hour and a couple were almost two hours.

At first, I purchased and planned to use a digital, voice activated recording device to record the interviews. These type devices have voice recognition software and I

expected that it could transcribe the voice interviews to text by computer, thereby saving a lot of time in the transcription phase. I had also planned to audiotape the interviews with an audiotape-recorder, as a backup to the digital recorder. I also took written notes during the interviews. The back-up recording plan was an important and good idea. It seems that I had not considered that the voice recognition software could only be "trained" to my voice. As a result, the student's voice on the first interview was not recognized by the software and the work needed to make sense of what the computer software offered was not worth it. Following the very first interview, I abandoned the digital, voice activated recorder and in all the subsequent interviews I relied on the audiotape recorder and handwritten notes.

Reflexive interview principles were applied during the interviews, meaning that the follow-up questions and conversation were based on the participant's comments, with my asking for clarification or for deeper reflection during the interview. Broad review and analysis were ongoing as each interview was conducted, in order to check for informational redundancy.

Interview Methods

My methods for interviewing (data collection) and analysis were heavily influenced by Kvale (1996) and by Van Manen's (1990) work on phenomenology. In particular, I worked hard to "bracket" my opinions and experiences during the interview process and thereby avoid predisposition to ideas and themes. One effort I made towards accomplishing this was to postpone the review of the literature until the interviews were collected and analyzed. Thus, the themes from the in-depth interviews were distilled from conversational interviews with the participants before reviewing the research on talented

and promising mathematics students and their experiences. This helped avoid any predisposition to make the emerging themes fit the literature.

The steps and flow of the research design are outlined in Figure 1. This chart is adapted from the work of Onwuegbuzie (2004) in the presentation of his mixed methods research. I find it helpful as a visual outline of the research process.

Transcription, Analysis, and Coding

I served as the only interviewer. Following the spring and summer interviews, I transcribed the interviews with the help of one assistant. The transcriptions were forwarded to the participants for member checking, that is, verification, correction and modification of the contents of the transcribed interview. All but two participants participated in the member check. Those that reviewed and verified their interviews indicated that the transcription was accurate and they had no corrections or modifications to make. They often commented that they were surprised about "how much was in there."

Broad review and analyzing data were ongoing as each interview was conducted in order to check for informational redundancy. In-depth analysis and isolating thematic statements followed. Van Manen (1990) described three approaches for determining themes from text analysis: the wholistic or sententious approach, the selective or highlight approach, and the detailed or line-by-line approach. After immersing myself in the interviews by reading each transcription completely at least two times, I used the detailed or line-by-line approach. This involves looking at every sentence or cluster of sentences and asking, "What does this sentence or sentence cluster reveal about the phenomenon or experience being described?" (Van Manen, p. 93). The analysis began with the actual language of the participants in the transcribed interview. Using their

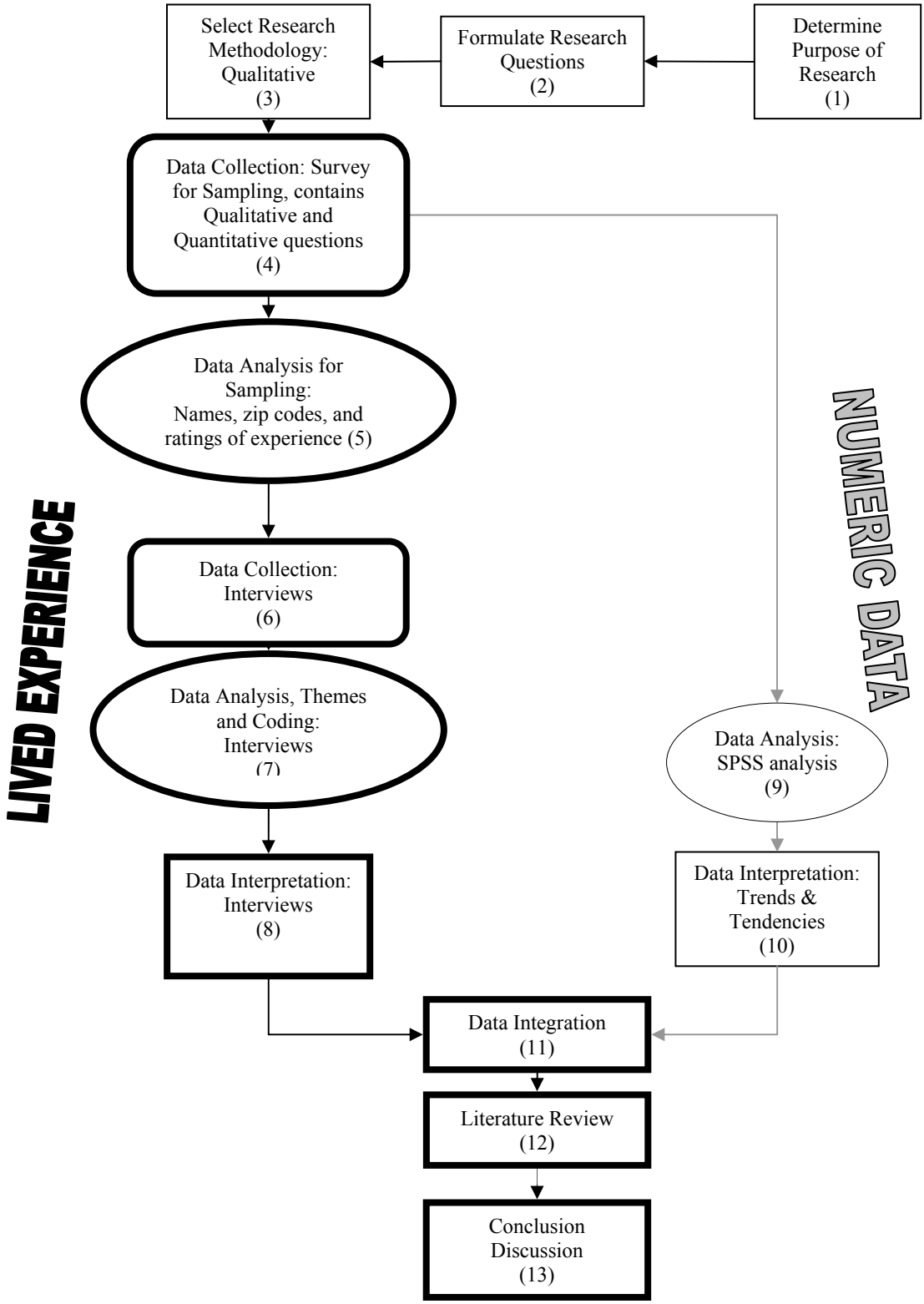

Figure 1. Flowchart of Research Methods.

language and stories, I asked myself, “What is the participant telling me that is key or important here?” I noted the topic or theme of each sentence cluster in the margins throughout the entire transcription. I reduced the data by recording all the categories named by each participant, noting which numbered lines of text were matched to the theme. This process was repeated for each interview.

When this was complete for each participant, I then reviewed and compared the themes of each person to determine which themes were related to or shared by other members of the group. These shared themes were reassembled into main categories, with all the participants’ possible variations on each theme recorded. Then I used axial coding to relate subcategories of responses to some main categories. The complete coding system can be found in Appendix D.

While closely related and definitely intertwined, the data analysis and the data interpretation were also treated as distinct and different activities, occurring in a focused and deep manner in different stages.

Following the conceptualizing of the themes I returned to review the surveys. The information from each of the 62 returned, readable surveys was entered into SPSS 11.0. For each of the questions that had numerical ratings, I ran the means, ranges, and modes of the responses and the ratings of satisfaction. I looked to see if the ways that the interview participants answered survey questions were similar or dissimilar to those who were not interviewed. Were the interview participants typical of the rest of the group or different? This was accomplished simply by comparing the two sets of data, the survey data of the interviewees and the survey data from the whole group (including the

interviewees). If they were similar, might these interviews also represent some typical experiences of those who were not interviewed?

Since I had these two data sources, I was able to conduct an aspect of data integration between the surveys and the interviews to compare the two. Did the consensus of the difficulties perceived with learning Geometry among the interviewees show up in what they reported in the 10th-grade survey? Did the students who were not interviewed indicate that they had any trouble with Geometry? Were the difficulties in Geometry and Analysis evident in the rest of the surveys? Were the themes that emerged in the interviews at the end of 12th-grade forecasted in the survey data at 10th-grade? Were there differences in the ways that students felt between 10th and 12th-grades? Having the survey data and the descriptive statistics was interesting and insightful. It allowed me to integrate the students' stories and some descriptive data. It triggered additional questions and analysis.

Because I had postponed reviewing the literature until after the themes had been determined and the data interpreted, the last stage of the design was to review the literature surrounding the themes that have emerged in the data. I started with the themes the students had helped develop and turned to the literature on that topic to see if it was consistent or not with these experiences and stories.

Validity of the Data

Kvale (1996) maintains that to *validate* means to check, question, and theorize. In the arena of "check," Kvale suggested the researcher adopt a critical outlook on the analysis, explicitly state his or her perspective on the subject matter studied and the controls applied to counter selective perceptions and biased interpretations, and in general

play the devil's advocate toward his or her own findings (p. 242). He related some of the various modes for "checking" on qualitative research and focused on those presented by Miles and Huberman.

> Miles and Huberman (1994) emphasize that there are no canons or infallible decision-making rules for establishing the validity of qualitative research. Their approach is to analyze the many sources of potential biases that might invalidate qualitative observations and interpretations; they out in detail tactics for testing and confirming qualitative findings. These tactics include: checking for representativeness and for researcher effects, triangulating, writing the evidence, checking the meaning of outliers, using extreme cases, following up on surprises, looking for negative evidence, making if-then tests, ruling out spurious relations, replicating a finding, checking out rival explanation and getting feedback from informants (Kvale, 1996, p. 242)

I endeavored to use some of the tactics suggested by Miles and Huberman (as cited in Kavle, 1996). One of those was attempting to interview the so-called outliers; another was looking for negative evidence. In searching for a purposeful sample, I categorized the 2 students out of 64 who reported their enthusiasm for math as "extremely dislike" as outliers. They were the first candidates I considered for interviewing. While I was not able to converse with any of these two outliers because they did not give permission, three of the students that were interviewed rated their enthusiasm for math as 2 (*dislike*), two rated their enthusiasm as 3 (*enthusiastic*), and one rated enthusiasm as 3.5. I also attempted to "follow up on surprises" by making three attempts to reach the student who had left his home before graduating from high school. And last, following the interviews and transcript processing, the students were sent or given their transcripts for review, feedback, and editing. Because I had more than one source of data, interviews and surveys, I did have a degree of triangulation. I experienced periods of cognitive dissonance about having that data, concerned that I had not adhered rigidly to the phenomenological framework which would have little use for survey data.

But I had it and decided to use it. Actually, not all experts agree on the role of triangulation in qualitative research. Kvale (1996) cited instances of disagreement with its use in qualitative research, but I thought Bogdan and Biklen (1998) put it best:

> Triangulation (originally from the application of trigonometry to navigation and surveying) was first borrowed in the social sciences to convey the idea that to establish a fact you need more than one source of information. . . . It carried its old meaning—verification of facts—but picked up another. It came to mean that multiple sources of data were better in a study than a single source because multiple sources lead to a fuller understood of the phenomena you were studying. Others expanded its use to include using multiple subjects, multiple researchers, different theoretical approaches in addition to different data collecting techniques. . . . in short, describe what you did rather than using the imprecise and abstract term of triangulation. (p. 104)

Kvale (1996) pointed out that a common critique of research interviews is that their findings are not valid because the subjects' reports may be false. In several instances, across the spectrum of all the participants, I compared what they said in their interviews to what they had said in their surveys of three years prior. In particular, the grades they reported in 10th-grade were essentially the same grades (in one case differing by one point) they recalled three years later. In the situation where I had two students from the same school who reported different experiences, they unknowingly corroborated details of the other's story. In cases where the story the student was telling seemed to be a new direction than what was conveyed in the survey, we conversed about it. For example, one student who rated enthusiasm of math in 10th-grade as "two" (dislike) was reporting experiences of "flow" and how he had become extremely enthusiastic. Because of the presence of the survey data, the themes and findings in the final analysis could be compared, corroborated or disputed.

I opened this section with discussion that Kvale (1996) stated that *to validate* means to check, question, and theorize. I have discussed the measures I took to meet the

issues of checking and questioning. Because this study was exploratory and descriptive, I expected to do little to no theorizing. Kvale noted that "Pursuing the methodological issues of validation generates theoretical questions about the nature of the phenomena investigated. Deciding whether a method investigates what it intends to investigate involves a theoretical concept of what is investigated" (p. 244). So, for me, on the topic of my research, this feels a bit like running in a circle, chasing a tail. Recall that while my intent was to examine the scope of possible experiences and not to distill the essence of it, perhaps this study would move us closer to understanding, eventually finding the essence of it.

Like Bogdan and Biklen (1998) said about triangulation, Kvale (1996) suggested that transparency, or telling what you did, produces all the validity one needs.

> Ideally, the quality of the craftsmanship results in products with knowledge claims that are so powerful and convincing in their own right that they, so to say, carry the validation with them, like a strong piece of art. In such cases, the research procedures would be transparent and the results evident, and the conclusions of a study intrinsically convincing as true, beautiful and good. Appeals to external certification, or official validity stamps of approval, then become secondary. Valid research would in this sense be research that makes questions of validity superfluous. (p. 252)

Lincoln and Guba (1985) proposed four areas that are indicators of trustworthiness in research. They are credibility, transferability, dependability, and confirmability. Both credibility and dependability were addressed through the activities associated with the ideas of triangulation, that is, the use of multiple subjects and both qualitative and quantitative sources of data, and member checking. As well, in terms of the interviews and analysis of the data, I have provided rich and detailed information to allow the reader to determine the extent to which I carried out the study and arrived at conclusions. I will make a case for transferability, the idea that the information,

hypotheses, or conclusions derived from the study can be useful in similar contexts, in the concluding remarks of this research. Dependability will be determined by the readers and reviewers of this research, who will make a judgment about whether the methods and processes merit such a label.

CHAPTER 3

FINDINGS: STUDENTS' EXPERIENCES IN THE ACCELERATED MATHEMATICS PROGRAM

Of the six students who participated in in-depth interviews about their accelerated mathematics learning experience that spanned six years, three were male and three were female. All were white. The students came from five different high schools from the northern, eastern, and western areas of the district. Attempts were made to include a student from the southern area of the district, but the potential candidates from there declined to participate. To protect the identities of the students, all names have been changed. The school names are fictitious.

Gregory

Gregory is a graduate of Wilcox High School. As Gregory participated in the hyper-accelerated math program, he took the sequence of math courses that would have been expected of a student who remained on track with the intended program. When he was in the 10th-grade, he completed a survey that was provided to all of the students on this path of study by the district mathematics coordinator. At that point, he had taken Algebra I in seventh grade (earning a grade of 99%), Geometry in eighth grade (grade of 94%), Honors Algebra II in ninth grade (grade of 96%), and Analysis in 10th-grade (grade of 93%). When he was in 10th-grade, he predicted that in 11th-grade he would probably take Calculus AB and BC (AB and BC designate the sequences of the two-part Calculus study) and then in 12th-grade he would probably take a math course through a

college joint enrollment arrangement. He rated his enthusiasm and enjoyment of mathematics on a scale of 1 (*extremely dislike*) to 4 (*extremely enthusiastic*) as a 3.5. He wrote, "Math is my best subject in school and also the most fun academic class I take." His postsecondary plans indicated that he would definitely attend college, but he did not know where or what he might major in.

In May of Gregory's senior year, I contacted him by telephone for a preliminary interview. On the telephone he indicated that as a senior in his last semester he was not taking a math course. He did, as he had predicted, take AP Calculus AB in the 11th-grade (grade 86%) and he took Economics in his senior year. He thought that being in math classes that "don't hold you back" most significantly affected his sense of satisfaction with the accelerated course of study and his most memorable experiences regarding this course of study were that "proofs in Geometry used to be a real pain and in Calculus a lot of differentiation rules got confusing." Gregory said that he would be attending the Peabody Conservatory of Music.

I decided that it would be interesting to know more about Gregory's experience because he had previously indicated that math was his best and most fun subject and yet in his senior year he was taking no math and was pursuing music as a major. I was not completely surprised by his choice to major in music as there is research about links between math and music, but I did wonder about a choice that was not characterized as mathematical science. I offered the opportunity for an in-depth interview and he accepted it. We would meet the week following his graduation at Starbucks coffee shop near his school.

I arrived at the Starbucks a little early to find a good seat, usually determined by the surrounding people, their potential conversations, their proximity to our conversation and proximity to an electrical socket in case I wanted to use my computer while waiting. I decided that in this location, there might be some difficulty in finding a good seat. Most of the people were seated near the door and the spots away from the door were very noisy with interactions at the counter and blenders whipping up Frappucinos and other coffee drinks. I did not know what Gregory looked like so I looked around to see if there were any 18-year-old-looking men in the place. There was a man seated near the door, in a suit, reading the newspaper. As well, there was a book signing going on outside the door on the sidewalk. It was Leo Mazzoni, pitching coach for the Atlanta Braves baseball team. I looked in that small group to see if there was an 18-year-old-looking man in that gathering. There was not and the book signing event began to clear out. I waited inside, watching the door.

Gregory arrived and I recognized him as an 18-year-old-looking man who had a look of searching and anticipation on his face. I was probably recognizable as an older woman that also carried a countenance on that day of searching and anticipation. He approached me and inquired, “Mrs. Whitlow?” My initial impression was that Gregory was pleasant, attractive, tall, slender, and dark-haired. He had an easy, confident smile and unassuming demeanor. He had graduated from high school on the previous Friday. Gregory had sandwiched this meeting with me between his graduation day and a student mission trip to Latin America.

After setting the context for the research and having him sign a permission form, I posed the following broad, opening question, “I am trying to learn just what it was like

for a student like you going through these math classes. You were a student who was chosen to take accelerated math courses beginning with formal high school algebra in the seventh grade, geometry in the eighth grade. What do you recall about what it was like to learn mathematics throughout middle and high school in your math classes?"

Gregory's first memory is that his seventh grade Algebra class was large and that the teacher was enabling. He felt that many students who did not belong or qualify for the class were put in it and that the teacher "probably helped students out a little bit more than she should have helped them out. So people would do well in that class." He said that he was not one of those and that he learned a great deal. He remembered, "It came pretty easy to me." He occasionally took advantage of the teacher's enabling behavior and acknowledged that this might not ultimately be good for one's learning. Gregory felt that this did not really affect him as he felt that he understood most of the math and that this did not cause him to study less because he was naturally a really hard worker.

> It didn't hurt me. Let's say there was a problem on the test that I didn't get. I could go up to her and she would work it out for me. The result would be that I wouldn't have learned because I wouldn't have gotten a bad grade on the test and I wouldn't have wanted to study a little more. But it wasn't that much of a problem for me because I basically understood most of it.

Gregory found it interesting that he and his sister were taking the same course. He was in seventh grade taking Algebra and she was in eighth grade taking Algebra. They did homework and studied together. He thought it was very helpful and that they worked well together, but he wondered if there was a little jealousy on her part because she was older and they were beginning to compete. He remembered feeling "smart" and "special" but noted that he did not feel arrogant. He recalled thinking that "I'm doing something special."

As Gregory proceeded to his recollections of eighth grade Geometry he shared that he made his first B and that it was his only B in all of middle school. This startled him and he questioned whether he should really be doing this. In turn, he worked harder and studied more. He said he ended up doing fine and he was complimentary of his teacher.

> I thought the teacher was a very good teacher. She taught the material and made sure we covered everything. I thought she did very well. I think there was some opposition because she did teach well and that means it is going to get hard sometimes and so some people didn't like that.

He reported that while he made his first B, others in the class were making Cs and Ds. He thought this was a wake-up call for many and that perhaps because Algebra I had come easy to them in the previous year that they were using the same study habits and expecting the same results. This result was that they were not doing as well. When he later compared his Geometry experience in middle school to those who took it in high school, he thought that his Geometry experience was more comprehensive, more in depth, more rigorous than what was being reported as the high school Geometry experience. With the impression that they were working as hard, if not harder than the high school Geometry students, Gregory and many of his classmates were upset that they were not awarded the extra honors credit that high school students receive for Honors Geometry.

> When we got to high school and people were telling us about the Geometry classes, proofs were kind of in the corner; they weren't center. For us, I think it was the opposite. Proofs were kind of in the center of what we were doing. And they were hard. I remember I didn't like them. One thing that we didn't like, kind of as a whole, as a class of people taking it, was that we didn't get the honors credits, and we felt, especially in Geometry, that the rigor of the course was worthy of it. But we didn't get it because it didn't work that way. So we were kind of upset about that.

As Gregory moved on to recall his high school experience, he reported that being back in algebra, Algebra II now, was a return to easier coursework than Geometry. He also noted that the classes now had older students in them. He recalled that the older peers made joking comments about the "smart young guys" but that he did not recall being affected by it. I asked, "Do you remember being pleased by it, upset by it, flattered by it? Did it keep you from being engaged?" He answered, "No, it was just something to laugh about." He did not remember anything that stood out in the Algebra II experience except that it was "just more in depth on the algebra stuff. Probably more laws that I have up in the memory now." He said that his Honors Analysis class was more challenging than Algebra II but that he still understood it well, did his homework and did well. He reported his grade as a 93%. Gregory commented, "I think I got a 93. I actually had a lot higher than that, but I didn't study much for the final because I didn't want to. I was OK. I wasn't one of those perfectionists going for the 100." This comment signifies a change in outlook and approach that Gregory described later. He went on to report that in the subsequent math course, AP Calculus AB, it was much more challenging and he started to slack off more.

He reported, "I wasn't keeping up with the homework as much and not doing the homework didn't hurt my grade because she wasn't grading the homework. But it did hurt my grade because I wasn't learning to do other things."

He was in the same Calculus class with his sister and again began to work on math with her. She struggled more with the mathematical challenge and working together helped them both. While he made an 86% in AP Calculus AB he posted a very acceptable score of 4 (out of possible 5) on the AP exam. His sister did not take the AP test.

> I was very surprised at my score. I got a 4 on it. That is one thing that the whole AP Calculus group can say, and that is that year, BC Calculus was not offered 2nd semester. We had to wait five months before the AP test, which didn't work out too well. So that is one of the reasons I was so surprised that I got a 4. You have reviews, but the bulk of the material is not going to be fresh. I don't think that is a problem with the accelerated math, but I think it is a problem with AP testing.

Gregory reported that the AP Calculus AB course was his last math course in high school. He was a junior when he took it. He had planned to take Calculus BC as a senior but decided against it because it was his last semester of high school, it had been a year since he had taken Calculus, and he "wasn't ready to torture myself." He acknowledged that he would have to take Calculus again in college, that it was good to have the background that he had, and that he would not use the AP credit to exempt Calculus because "I just plain don't remember enough of it."

At this point in the interview, my heart was sinking and the Starbucks iced tea in my stomach was rising. My greatest fears had been confirmed. I had always worried that students who completed the 4-year math requirement for graduation early might stop taking math, opt out of it during the last year of high school. I was thinking at this moment in the interview that this is not good. There is research that correlates success in college to taking almost any type of math class as a senior in high school. Luckily, thankfully, I continued to ask what proved to be the right questions. I said, "All right, that takes us through high school. Ask yourself, have I helped this lady understand what it was like to be me in high school math? Is there anything else?" The treasure began to be revealed.

> Gregory: I am glad that I got to do it. Because I was ahead in math it made my schedule work out better. Because I was also in orchestra, it is hard to schedule stuff. It makes your schedule very full. Being able to take the math early like that allowed me to take more of the other stuff.

Me: Because you took math and orchestra. It wasn't that you took more orchestra, but that you had room to take other things?

Gregory: Correct. For instance, I got to take AP Music Theory and I don't think I would have been able to if I hadn't taken the accelerated math.

Me: OK, so for you then, it gave you options.

Gregory: Yes, it did. Definitely. And because I had taken Calculus in my junior year, it also opened up options for me to do a joint enrollment. I took English both semesters. I took Econ and Psychology. I'm really glad that I did that, especially for the English because the approach that they took in college was different. A lot more freedom in writing. So I think that allowed me to improve my writing because I know this past year my writing has gotten so much better. Better than it has through my whole course of high school.

Gregory went on to describe how you could not take risks in high school writing because teachers require formula essays and experimentation could result in failure. He described how his college English class encouraged innovation, that much feedback on writing was given, how students were taught to use the style and techniques of other good writers in their own writing and how at Wilcox High School he had never had those experiences.

> The reading we did in high school focused on interpreting the reading. But the reading that we did in college focused on seeing what the writer did and seeing how we could use that in our own writing. So it wasn't so much interpreting it and trying to analyze it a million ways, which I think can get unnecessary. It focused on seeing what the writer was doing in expressing their ideas and trying to incorporate that in your own writing. Whereas in high school, we had never done that. Not once can I think of an instance where the teachers said, "Oh look at what this writer did; why don't you try some of this in your own writing?" I just don't remember that at all.

I explained to Gregory that I was hearing excitement from him about his interests in writing, literature, and music and that I was wondering how his "gifted math" label fit with his interests. He said that it was very important. He explained that he had been accepted to the Peabody Conservatory of Music to pursue a double major in Recording

Arts and Sciences and Music Composition. He explained that without his math background he would not have been accepted into the Recording Arts program. He elaborated that the Recording Arts program would place emphasis on acoustics, electronics circuitry, and electrical engineering and that acceptance to the program was contingent on a very strong math background.

The in-depth interview was intended to capture understanding of the student's experience on this path of study, understand how the student defined success or satisfaction with this endeavor, and what the student attributed the attainment (or lack of) of success to. At this point in our conversation, I turned to the discussion of success and satisfaction. Gregory defined success as reaching a goal. He felt that it could be a vague goal or a defined goal, but reaching it and attaining it were success.

> I don't think the goal was clearly defined when I started taking the accelerated math classes but I think somewhere in the back of my mind was to learn as much about math, as best I could. And I think I was successful because I learned a ton of math. And especially, it didn't hold me back. I didn't have to wait to get to the more difficult math classes.

Gregory also believed that all people are created with different gifts, talents and strengths. He attributed his own success to being given the gift of intelligence from his parents and to his own good work ethic.

> In my sophomore year and before that – a really good work ethic. I guess that's just the way my parents have raised me. I always made sure I did my homework. I was really on top of that. I would say that the big thing is the work ethic.

Then he began to explain that he had gone through a change. Early on he wanted to learn a lot and make top notch grades. Then he said that in his junior year he "didn't have as much of a need." He explained that previously, successful schoolwork and high grades were definitely a part of his identity. Now,

> I got a bigger perspective on everything and before my sophomore year schoolwork was like everything. After my junior year, I had a bigger perspective. My life is not all about schoolwork. Whether I get an A or B in class does not determine whether I am going to be successful later on in life. I was just working for something that is just going to pass by in a year or so. I wasn't willing to completely ease off on it. I didn't make it the center of my life anymore. I still cared about school. I didn't stop caring.

As he reflected, he spoke of what might have happened if he had not worked hard on this path of study and compared it to his peers' reports. He explained that students who were in his sister's class (the cohort of students a year ahead of him) complained that when they were in the seventh grade math classes that they were not learning anything new and they considered it a waste. They wished that the acceleration program had begun a year earlier so they could have done it. In turn I explained that it was a very tough decision to make and that I had always been concerned about students who might be put in such courses and not have such a good experience—too much, too soon, too fast. He mused,

> It is really hard. You can't tell who is going to be good at it. You take two students and one might take one path and do very well and the other one might not. I think that problem solved itself in high school, especially after Geometry. Some people decided to go into Honors Algebra, some decided to take Geometry again. It works itself out. Geometry is probably a struggle for some of them, but once they are out of that they had the freedom to decide. That allowed the problem of people not belonging there to work itself out.

Gregory spoke well of all of his teachers throughout this experience. He thought they taught well, that they appreciated the gifted math students, and that they treated them well. He did not include any mention of them in support of his success and he thought they overrated the mathematically talented students. He said he did not agree with teachers who might think advanced students were intellectually superior. "I think part of

it is just working at it. I think that it was just how hard we were willing to work to learn the stuff."

Since the interview, Gregory has attended the Peabody Conservatory of Music and has already won awards for Music Composition from the American Society of Composers, Authors and Publishers.

Darren

In my first attempt to reach Darren by telephone, there was no answer. After subsequent attempts, I reached someone at his home about five weeks later. This time Darren was not home, so I explained to his father who I was and why I was calling and asked if I could leave my phone number for a return call. His father informed me that he was sure that Darren would want to talk to me because "he did not qualify for the program" and that the middle school he had attended was "not cooperative and gave him hell." I was immediately interested in his story, assuming that his father meant he had encountered roadblocks and difficulties. Apparently he had overcome them as he had completed the program, at least through the 10th-grade when he filled out the survey giving me contact information and permission to contact him. On the following day I received the return call from Darren. He participated in the telephone interview and we set the interview date for the very next day.

Darren told me during the telephone interview that he was not taking any math during his last semester in high school, that he was very happy with his accelerated mathematics experience and that he had received a Congressional appointment to the U.S. Merchant Marine Academy. He indicated that the degree to which he felt prepared to attend the Merchant Marine Academy in engineering most significantly affected his

sense of satisfaction with the accelerated course of study. The strongest memory that he associated with the years of math study was "Boy, it was hard! It was a long struggle. I enjoyed math. I had fun doing it and that was a big motivator." He sounded very excited, and my curiosity in this young man's story was piqued.

The next day we met at a Starbucks coffee shop that was attached to a large chain bookstore. I arrived early, hoping that we might be able to sit outside as it was a pleasant Sunday afternoon. All the tables were taken and there was also a crowd inside. I chose the only available table that was on the edge of the room, very near the shelves of books in the bookstore section. When Darren arrived I saw a young man with an inquisitive look about him and a big cheerful smile. From the look of him, which just exuded cheer, I would have figured that he was the young man I was to meet but as he was also scanning the room for a face, I felt confident this was Darren. He was somewhat tall, had a large build but was not heavy and had sandy brown hair.

Darren had just graduated from Davis High School. After the preliminary explanation about the intention of the study and the signing of the consent forms, I began the interview. I posed the question, "What do you recall about what it was like to learn math throughout your middle and high school years in this accelerated learning program? We can start back with seventh grade; how it was, what it was like, what you might have been thinking and we'll move up through the years." He asked, "It started at sixth grade, right?" I said, "Yes, it technically started in the sixth grade. You can start there if you want." At this point, he smiled and leaned in toward the table with his entire upper body and said, "Yeah, I had a pretty interesting experience." He launched his story.

> You might know that they had us sign a form after we got out of sixth grade to allow us into the seventh grade [accelerated math class]. I think

> my sixth grade was like 100 and I thought for sure I would be in the higher bracket. I learned that there was a test that we took earlier so they were going to put me in the lower class that wasn't accelerated. But I didn't want to do that. I wanted to be in the higher class so I had to get a waiver signed for that. So after I got that done, I have to say that Algebra is actually one of the most difficult classes that I have had of all the accelerated math.

I began to probe both the struggle to get into the classes and the struggle with the content in Algebra I. The struggle with the algebra poured out. He felt it was different from anything he had ever done before. He was studying so hard, but he could not understand what was going on. He said it was ridiculously fast-paced, even the smartest students were having trouble, and he could not make a B. He figured it was new material and something he was not used to. When I asked what made him want to get through such a struggle and how he managed to get through it, he said,

> I just enjoyed math. That's the only reason why I should have been in that accelerated math class because none of the tests I took would have permitted me to be in any of those classes. In fact, I had to get waived into Pre-Algebra. I was one of the enthused students in the class because I actually cared. All the other students, they deserved to be there because of their test scores. They didn't care as much about it but because I did, I ended up being better than they were. So that pretty much is what motivated me.

This young man was pure determination! I asked if somebody helped him with the math and supported him through the struggle. He explained that his parents were of little help with the algebra so he just worked hard. He said that he did not want to make any bad grades, especially as he had fought so hard to be in the class. He had an extremely strong desire to prove himself. He said that Algebra was "ugh," though somehow he made it through Algebra with a grade of 88%.

In describing the struggle with getting into the classes, Darren spoke of how disappointed he was to not earn placement in the accelerated classes. He had missed the

criterion on standardized test scores. I explained to him that criteria were often in place as an attempt to guarantee a student's success in a given setting and that lack of criteria did not mean a person could not do it, just that the district or school was not guaranteeing it would work out. In listening to his story, I was glad that he had displayed the determination needed to secure the waivers. The descriptions of his fight and determination to get into these math classes indicated that this fight was woven into the fiber of his whole experience.

The struggles abated in the following year. He did not need a waiver to get into the accelerated Geometry class. The learning became easier when he met another student who became his friend and his competitor.

> One of the things that really helped me in that class was that I met a friend there who was, like, brilliant. 1500 on the SAT type of kid. I just competed with him to try to get better scores. I never did.

Darren befriended this student and competed with him in math classes throughout Geometry, Algebra II, Analysis, and Calculus. During the interview he wondered how they would both do in the future, still really good friends, moving away to college, with keeping in touch, and with no more competition.

As Darren continued to reminiscence about his classes, he recalled that when he hit algebra again, in Algebra II, things were much better. He thought that it "clicked" and that Algebra became a real area of strength for him then. He said that the teachers in high school began to slow the pace down because there were older students in his classes. This slowing down of the pace of instruction made things easier for him:

> They slowed it down. It wasn't a new topic every week. It was not geared toward the genius kids that they were back in seventh grade. Not as smart. They slowed it down a little bit and made it a lot easier. It was more bearable.

As well, he described a change in his source of motivation that occurred during ninth grade. Previously he was motivated to prove himself worthy of all of the waivers and he did. He described a change toward getting the most out of his classes. He related that he had the dream and goal of getting into marine engineering school since the 4th grade. At that age he was inspired by his older brother who was working in marine engineering and of his stories of travel to Europe and Greece. He also knew that learning math was part of accomplishing that dream and goal. He had stuck with that dream since the 4th grade.

He was thankful that he did not have to "prove" himself on a test again to move on to Analysis. He recalled Analysis as being more exciting and he loved the higher levels of algebra that he was required to use on everyday, real problems. He and his best friend competitor continued their "same old competition thing." Darren said, "I really enjoyed being in the same class with him. I was definitely happy with that class. I was freaking out! It wasn't too difficult and I had a good time."

In 11th-grade, Darren took AP Calculus AB and BC. His grade was a high B or A and he made a score of 4 (out of 5) on the AP Calculus exam. He described the year of Calculus as being pretty difficult and very high speed. He was still motivated to avoid scoring below a B in the course and still motivated by his friend, who "always makes it easier and is fun to be around." Darren said he planned to take Calculus again when he went to the Merchant Marine Academy and noted that any time you do something the first time it will be hard. He thought that his previous experience with Calculus would serve him well. When I asked why he did not take a math course as a senior and if he was

concerned about that, he said he had accomplished what he wanted to. He filled the slot in his schedule with Track. “I really wanted to do that.”

> To tell you the truth, I was just tired of taking math. I was just worn down. I had an AP Physics class. It is definitely a math class though. I was just not interested in statistics at all. It’s not what I wanted to do; didn’t sound interesting to me. And it just seemed like I had accomplished all that I wanted to do. Once I got done with Calculus I felt I’m done. No more.

At this point I turned our conversation toward definitions of success and if he felt successful, what he might attribute his success to. Darren defined success as getting the grades in math that he wanted, getting accepted to the school that he had always wanted to attend and happiness. He definitely felt successful.

> Happiness. Happy with your accomplishments, happy of where you are going in the future. Doing what they said I couldn’t do. Trying to get something out of the class. Just to have a good foundation in math, algebra, calculus.

First on his list of what he attributed his success to are his parents. They talked him into pursuing the waivers with “You want to be in that class? Why don’t you go into that class?” They also supported him when things got very difficult by saying that he could drop the course if he wanted to. He said that they never made a big deal of things or put any pressure on him to succeed. Darren affectionately mused, “Really great parents.” Then he credited his success to his own hard work, his own motivation to do well and his competition with his “great friend.” He summed up with, “Parents, my own motivation, and competition.”

Robert

Robert is from Timer High School. It took a couple of attempts to connect with him by phone as he was first busy at an athletic practice session and then speaking at the Baccalaureate for graduation. His mother said he would try to call me but he was running

a tight schedule and was probably pretty tired. Right away I figured out that Robert was a busy young man and I worried about whether he would or could make time to talk with me about his mathematics learning experience. Even before talking with him I felt a sense of celebrity about him as I realized that he was most definitely a student leader. He did indeed call me back for the telephone interview and though he was leaving within a week, first for a family trip and then for the Air Force Academy, he agreed to meet me for an in-depth interview.

What I learned from Robert during our telephone interview was that he would be attending the U.S. Air Force Academy and would major in Mechanical Engineering. He had taken math in his senior year of high school, was "most satisfied" with his experience of having taken accelerated math courses for the previous six years and was particularly happy that he had two years of Calculus and one year of Physics. One of his most memorable experiences was taking the AP Physics test as an 11th-grader and scoring a 5 (out of possible 5) on it. He said that he appreciated the types of classes he had taken, the caliber of the students he went to class with, and the good, dedicated teachers. We set the interview date for two days later.

The Borders Bookstore coffee shop, where we were to meet, was almost deserted at 2 o'clock in the afternoon on a Wednesday. We found each other easily as there was only one other man in the coffee shop. At first glance I was taken with his aura of confidence and easily carried, striking good looks. I still felt the air of celebrity about him. His hair was groomed and he was of medium build. He seemed strong, lean and fit. He was tanned and had a perfect, broad, engaging smile that lit up his face. As we began to talk I realized I was with someone who was more than just good looks, but who was a

thoughtful, serious young man. One thing that struck me was that Robert was very concerned throughout the interview about whether I was getting from him what I wanted in the interview. He asked, “Am I providing sufficient information for each year?” and apologized when he could not remember any more about a topic. I assured him a couple of times that whatever he had to tell me was exactly what I wanted.

After I set the background for the interview and Robert signed the consent form, we settled into the interview. Robert easily began to talk about his seventh grade Algebra class. He recalled it was supposed to be something totally different and challenging. He and his peers felt like they were on a new frontier; “pioneering” he called it. He explained that the messages at the school and district level had hyped the course quite a bit. His first reference was to his teacher. He thought that she was excellent and that she taught in ways that helped students understand the math and physical representations of it. He remembered that it was difficult but never too difficult. He spoke of not always understanding exactly what he was learning nor the whole impact of what he was learning, but he figured that there were just some things that had to be learned and memorized. Upon a couple of occasions he referred to some of the experiences as “boot camp.”

Robert remembered doing proofs in Geometry class and thought that was valuable. Like Algebra class, he thought Geometry was difficult but not too much so. He reflected that while things were more challenging than before it never felt like it was anything he could not handle. He studied more than before. He said, “It felt like it was challenging but I was with a lot of students that were in the same boat as me. We all thought that we could do it.”

In ninth grade, Robert found Honors Algebra II to be a different type of experience because now there were older students in his classes. He was surprised by some of the 10th-graders in his class who were "very gifted and had a severe case of senioritis already." Content-wise, things began to come together, like putting the Cartesian plane together with the concepts learned in Geometry. Robert thought that each year, each course, made his understanding of the previous courses and concepts clearer.

> Then with 10th-grade Honors Analysis I think I was taking what I had learned so far and was shaping it all together. But there was another time with the unit circle and sine and cosine and I felt like, I know what this means but I have no idea of the meaning behind it. It wasn't until I took Physics and Calculus that I actually grasped the entire concept and the value of that kind of thinking.

At the end of 10th-grade Honors Analysis, Robert's grade in the course was 92%. The cut score for placement into AP Calculus BC was 95%, so he was placed in AP Calculus AB. In this Calculus class, he was doing so well by the end of the first semester that the teacher "bumped me up" and he was placed in AP Calculus BC for the remainder of the year. He said the only thing he remembered as being different between the two Calculus courses was work with Taylor Series. He scored a 4 (out of possible 5) on the AP Calculus exam and proclaimed it to be the easiest year of math study that he had ever had. The previous year had not been easy.

> That was the year I was introduced to physics and calculus at the same time and I remember the first couple days I took physics and was learning calculus at the same time. The first time you see a derivative and you realize its significance on a graph and especially looking at graphs in physics, it blew my mind. I just stared at a wall for an hour after class sometimes just to sort everything out, to get it all straight. Because understanding what acceleration is in reference to velocity and processing it all. . . . Now it's pretty elementary but at the time it was something totally new.

I was curious about how he had managed to stick with the challenges of learning some difficult content during the years when things did not entirely make sense. As he had said, things did not really come together until his junior year. I asked, "How did you keep yourself going when this probably wasn't easy? You kept yourself going all the way until you put physics and calculus together at the same time in your junior year; finally getting excited." He grinned.

> Took a while, right? How did I keep myself going? School's your job for that part of your life. You take it like it is most of the time. I'm not going to lie to you. Before everything started coming together, I was not a math fan. I didn't take the math final. I exempted all my math finals up to that 10th-grade year because I wanted to. I didn't want to deal with it any more after I had done the whole course. If I could have exempted it, I would. The first couple of weeks of junior year I felt like my brain hurt afterward. It almost felt like someone was taking your brain and turning it to a totally different direction and making you think something totally different. That was when it kind of changed for me.

How much did things change? By the time Robert took the last exam in AP Calculus BC he thought everything came so much easier. "It flowed," he said. From the time that he rated his enthusiasm and enjoyment of mathematics during 10th-grade as a "2" (*dislike*) to the day of the interview, he had changed. He laughed hard and said that he would now rate it as a "4" (the highest rating, *extremely enthusiastic*).

> It is what I want to pursue. I know that. When I say pursue math, I'm not a theoretical math guy. I don't want to go into theoretical physics or study advanced math. I'd like to delve into more practical areas, strictly in relation to some type of science. I think I'm going to major in mechanical engineering. I'll be dealing with a lot of limits, variables, exact measurements, things like that. Tangible mathematics, if that's a term.

Robert was open in talking about peers' and a best friend's experience with this path of study. I was interested because this would be the only way I could gain insight into the experiences of the students who did not give me permission to contact them. His

best friend from elementary and middle school began the accelerated math classes with Robert in the seventh grade, but it was too much for him and he got out of it.

> Well, for him I think it was the right way to go. I think for a lot of people, what they have achieved academically is a direct result of how motivated they've been and how much effort they put into it. For him, his priorities and his family's priorities are not as focused academically as maybe my family's or someone else's. Pure intellect-wise, he was more than qualified. But I think he decided that he didn't value that.

Robert went on to say that he had recently counseled this same friend into taking Calculus rather than Statistics because he thought it would be valuable for his friend to get some exposure to it. His friend was afraid of the workload but Robert explained that exposure to something is good. Regarding his friend's exposure to Calculus now and taking it again later in college. Robert said, "It is not going to hurt as much when he does it. He took AB and I took BC. We are sitting in the same room this month." Robert had some definite ideas about Calculus. "I think Calculus is pretty cruel. Don't even worry about your validation for that credit. You get the experience and you've seen the stuff before. That's what helps," he pronounced.

His perspective on peers and their experiences was that a bond was formed among this group of students. He thought they were, over the years, the same people, same classes, and they had shared in the same challenges and the same frustrations. They encouraged each other and competed with each other. They measured their degree of struggle against each other. If everyone else was doing well and you were doing horribly, something was wrong. If everyone was doing horribly and you were doing horribly, then it was okay; maybe you were not doing so badly after all. He thought it helped them to learn if they could help and teach each other things. He liked learning with his peers and

felt that they constantly challenged each other. He said, “We kept pushing and pushing each other along.”

I turned the discussion to the definition of success. Robert explained that his definition of success had also changed over the years. He reflected that up until the prior year he would have told me that success is measured by how close to 100% your grade is. Now he said he believes that while there is nothing wrong with doing well and that is important to be able to prove your knowledge, success is understanding. He claimed, “Making sure you understand the subject matter is paramount. I’ve been most successful. I am prepared for going into intensive college work.”

At the top of the list of things, people and qualities to which he attributed his success are his teachers. He credited his teachers throughout his experience with dealing with the developmental stages of learning and their talent in putting all the basic pieces together, in the end, “shaping it into a cohesive whole.” He thought all of his teachers did a great job. Next, he named his parents. They were supportive without pressuring him for high grades. They were empathic, worked with him on concepts they did not quite understand, gave advice and strategy. “You did your best. Your best is good enough for us. If you get a B or C along the way, if that’s your best, that’s your best.” Robert felt that his own motivation contributed to his success.

> I guess I was motivated to make the most of my time in high school and be as knowledgeable as I could. I guess that’s the purpose of all the schooling we go through. During the last couple of years, as I’ve matured, I’ve seen more areas where math is applied and realize that it is one of the best fields you can go into. At least, something related to math is probably one of the best fields you could go into for job opportunities and making money. People associate engineers as being so cold and sterile, but I mean, quite honestly, they contribute a whole field to the quality of living here in America and around the world. So it’s an honorable thing to do.

Robert wanted to be sure to include that "those little AP preparation books" were helpful. He mused that it's important to understand and stick with it "even though you don't like trig [trigonometry] or think it's the pits so that when Calculus came along you weren't stumbling over that. It's hard enough to figure out what they're trying to teach. You don't need to have trouble with the stuff that you're supposed to know. That's why I advocate those review books that give you the short itemizations of everything."

As we concluded the interview, Robert expressed interest in knowing what the new frontiers for accelerating students was like. He advocated this path of study for students and didn't believe that there was a way to start too early on algebra. His only advice was to have teachers continue to find a way to make some practical application of the mathematical concepts. "I don't know if some of that stuff can find a practical application, but some of the stuff you can find a model or an illustration for it." Since the interview, Robert has continued his college studies at the U. S. Air Force Academy.

Carla

Carla's 10th-grade survey was interesting to me. She had rated her middle grades math experiences of Algebra and Geometry as 2 on a scale of 1 (*negative*) to 4 (*positive*). Her rating of overall enthusiasm and enjoyment of mathematics at that time was also a 2 (*dislike*). Her comment then was "I have had enough of math right now," but her plans indicated that she would still be taking math, AP Calculus and AP Statistics, as a junior and senior. I was definitely interested in her possibly negative experience and in exploring the space between her lack of enthusiasm about studying math and her plan to continue taking difficult and complex mathematics courses.

I began trying to reach Carla in April, a month before she was due to graduate from Eastside High School. About five weeks later, I finally reached her and she participated in the telephone interview. During the telephone interview, Carla told me that she had taken AP Statistics during her senior year in high school. She reported that she was satisfied with the experience of participating in accelerated mathematics classes during the previous six years. She said, "I liked the experience of challenging courses" but said that she did not have qualified teachers during middle school. She thought that being grouped with other students who understood math and had the same thinking had most significantly affected her sense of satisfaction with the accelerated course of study. Carla shared that her most memorable experience was that she had to work "really, really hard for an A." As well, the first time she ever had a B in a course was very stressful and she had to work very hard for that. She continued by saying that during this course of study was the first time she had ever experienced not understanding something and that she had cried. She said that she told herself, "I know I can do this." Carla and I agreed to meet for the in-depth interview two days later at the local public library.

Carla had long blondish hair and she was thin with a slight build. She was smiling and pleasant, but she spoke very quietly and tentatively, as if she might be shy. Together, we found a small, empty conference room in the library. After I explained the background of the study and she completed the permission forms, we settled into the interview.

I began by asking Carla about the courses that she had taken in high school. In ninth grade, she took the advanced course that she was on track for, Honors Algebra II. In 10th-grade, she moved as expected to Analysis, but she was also placed in a gifted class

version of it that the school called “Synergy Analysis.” In 11th-grade, Carla took AP Calculus BC; in 12th-grade AP Statistics.

As she had mentioned on the telephone, she repeated that she was happy with the experience and had found it challenging. She was dissatisfied with the order that the courses came in and said she wished she had switched the order of AP Calculus and AP Statistics. She felt this would have helped her remember it. She again mentioned that it was satisfying to her to be grouped with other students who understood the same concepts as she did, and said, “I hate being grouped with people that don’t know what they are talking about because everyone that you are grouped with can go faster.” I decided to probe this by repeating her statement. She continued, “Yeah. Had the same, like, thinking.” I repeated this statement as a question to see if she would say more. I wasn’t certain if she meant that the students were all of the same opinions, if they all thought with speed, flexibility and creativity, or what exactly she meant. I said, “Had the same thinking?” Carla affirmed with “Yeah.” Still unclear, I asked her to give me an example of how she could tell the difference between those with the same thinking and those without. She explained, “You can tell the difference when you are grouped in those classes and then you go to your other classes. Like when it is a regular Honors class, you can tell the difference because you go slower and you get bored more.”

What Carla was referring to with a regular Honors class was that the school had created an additional level for the Honors-level student. To be an Honors-level student had previously been the highest possible placement for a talented high achieving student and a high demand was placed on the Honors-level student in terms of rigor, workload and high expectations. In this district students receive additional credit called a quality

point when they take an Honors level class. This quality point is added to the student's course grade, so instead of receiving a course grade of 3, the student would receive a grade of 3.5, thereby raising the student's overall grade point average or GPA. This school had further stratified this top layer into two layers. Now they had the gifted Honors student and the regular Honors student that Carla had referred to. The regular Honors classes were what she found slow and boring. Those students labeled "advanced" and "gifted" were in faster-paced Honors classes, called Synergy.

Carla described that the first time she had ever had to work hard for a grade was in Analysis in 10th-grade.

> My sophomore year in Analysis was the first time that I ever even like came close to a B. It made me really stressed out. It was the first time I had had a B and I was working really hard to get an A. Once I got the A it was kind of fun.

I wanted to know if this was the first time that she had ever had to work hard. She nodded and spoke quietly,

> Uh huh. In anything. It was the first time I had the experience of not understanding what was going on. I always understood everything that was going on. Got it the first time. This was the first time I had to actually sit down and learn how to do things or go in for extra help. I was really motivated so I went in a lot for extra help because I hate not understanding anything. But it also stressed me out a little bit, not too much, but—

She had trailed off with the previous comment, becoming quiet and thoughtful. I asked her how the stress played out for her and she revealed that she would get very upset at night and cry. She would get up and do it again the next day, repeating the cycle. I asked her what was going through her mind during this stressful time. A lot of self-talk was getting her through it. She said the following was going through her mind. "Well, I know I can do this. I would think about it and think about it and I would know that I can do this. I'd go back for extra help and figure it out and keep learning. I can do this."

At this point, I asked her to walk me back through her middle grades experience with the accelerated program of study.

> sixth grade we started with Pre-Algebra. I don't know how they figured that out. I guess in 5th grade they figured out your test scores and put you in Pre-Algebra. That was real easy because half of the people go into Pre-Algebra. So everyone goes and it is real easy. It was all real repetitive stuff and so I had 100. I don't think I ever did any homework at home. Then the next year they say "You are going into Algebra I," which was more challenging but it was also pretty easy at the same time. I don't know, it was logical. So that was pretty easy. Everyone was grouped together with the people who understood math more so that was nice. The eighth grade was Geometry and that was hard because I think I'm more of an algebra person. There were times when we really didn't know what we were doing. You'd ask her [the teacher] a question and she didn't really understand. We never knew how to do proofs. I think we did one and that's a big part of geometry. That was kind of frustrating. We never knew how to do it. I don't like know knowing how to do it.

Carla recalled going on to high school and being put in the Honors Algebra II class. I inquired about being "put" in the class. She explained,

> There is Synergy and there is just regular. So everyone else that went from Geometry went to regular or Honors and they selected a few kids to go to Synergy. I did the Honors. They didn't ask me to go to Synergy. So when I did Honors the first semester, the teacher had her son get sick or something. I don't remember exactly, but she had to leave and we had a substitute teacher come in and it was horrible. She didn't know what she was talking about so we had another one come in. After that, it was just kind of annoying because none of them knew what they were talking about.

Carla explained that she coped with this situation by teaching herself, but she noted that many of the other students did not do this. She said, "Some people just didn't understand it and like, give up. I don't like giving up. I just figured it out all by myself because it wasn't that difficult." Carla shared that some of her peers that did not teach themselves got low grades like 70% and 60%, and one friend got a 70%. In this school system the 70% equated to a grade of D. Carla's friend continued to take advanced math courses but not as high level as the ones Carla continued to take. Carla hung on and in the

spring semester of that year she got a really good teacher. She explained that she did well and things became easy for her after that. She also was "moved up" to Synergy level class in the following year. Carla described her move to the Synergy Analysis class as "probably the hardest class I've ever taken in high school, in all of high school." She described the experience:

> Everything is different. Like, it goes way into depth of everything you've ever learned and things start becoming more challenging – more in depth. You got to think a different way, not so logical like Algebra II where everything had a set pattern. Do it in this pattern, and then everything gets mixed up and there are things that you have never seen before. Then she [teacher] went very fast and Synergy had two extra chapters so we went fast, very fast. One day you are on something and the next day you are doing something else. It's just gone. When you get to the test, some of the teachers put the same kind of problems on the test and you just have to work them out just like the homework. She changes it. She made it so that you have to think on a test. You knew about the homework but then contort it!

Carla said that she eventually adjusted to this demand for adjusting and thinking, but not before she failed a math test for the first time. Actually, she failed two or three math tests in that class.

> They are just harder tests than I've ever taken. They are different. The first time I cried. I cry every time, but I get upset when I fail a math test. Like, failing is not a good feeling. Then I learned how her style of test was, and she knew that her class was hard though. She made up opportunities to make up. She gave us the chapter and if you did a review for the finals. . . . If you did all the work she put in the review, she'd drop the test for you to put in 100 because you did the whole review section. So I would make sure I did the whole review section so I'd make sure I got extra credit. I made sure I got that. She did a lot of things at the end. She knew her class was so hard.

Carla described how this whole process played out for her and the effects that this had on her grades.

> I failed two of the three tests and one of them was so low that when the review thing came I had an 80%. It bumped my grade up to an 86%. Then she put in a 100% quiz grade. That got me up to 87%. Then my second

> lowest test grade was a 50% or something. She'd take the 50 and if you take her final she will put it in a test grade and count it as your final. The final in her class counts 15% of your grade where everything else counts 10. My lowest test grade was like a 50. I got 93% on the final so she put that in place of the 50, so it boosted me up to an A. I studied so hard for that final. I figured out my grade and I knew exactly what I had to get. I knew that I could do that.

Ironically, although Carla was making Fs in the class, she was certain the teacher supported her. The teacher always stayed after school until as late as 5 p.m. to help Carla. Carla stayed late to meet with the teacher at least once a week, depending on how much help she needed or when she did not understand something. She never failed to ask for help if she needed it. Carla said that when she looked at the final exam she knew exactly what she was talking about and made 93% on that final exam. As she went on to Calculus, she said she knew what she was doing. Though this course finally ended well with a grade that she could be satisfied with and ultimately gaining understanding of the content, as she reflected she pronounced that she "hated it. I wish I hadn't taken that class. I wish I had taken that class in 11th-grade." She reflected that her sophomore experience was overwhelming and that after that she knew how to handle time and stress better. She would like to have been able to turn back the clock and place the course later her high school schedule.

Carla went on to AP Calculus BC as an 11th-grade student. She felt that Calculus was new, basic, and not too deep, that it was much easier than her Analysis class. She thought that Calculus made a lot of sense and was very logical. However, she reported that the teacher never gave tests back "all semester." This was frustrating and Carla said she never knew where her grade came from. She explained this teacher's behavior by saying that the teacher "could tell who knew what they were talking about." I asked Carla what her grade in the Calculus course was based on.

> I don't know what our grades were based on. We never did find out. At the very end of the semester I think he based it on these review packets for the AP test. I did every one and I got a 100 on that. The last three tests, which were all review for the AP test, I got good grades on them. I don't remember what they were exactly, but they were good grades. I think he basically worked with that. I had no idea.

Carla made a grade of 90% in Calculus. She said the class remained curious and frustrated about the source of the grades and how they were doing. She said that everyone in class would inquire, "Can you give us our tests back?" He would say, "You'll get them back later." Carla continued, "But he never did. So we don't know where we got our grades from."

Carla took the AP Calculus exam and scored a 4 (out of possible 5) on it. She was planning to use the AP score for college credit, but she thought she needed to take Calculus again at Georgia Tech University. She described her future plans at Georgia Tech and her decision to major in Biomedical Engineering.

> I have always been a math person so when I knew I wanted to do something in math or science. I was going to do chemistry because I want to do forensic science. But if I do chemistry I have limited job options. I really didn't want to be a high school teacher and I didn't want to work in a lab. So, biomedical engineering. I would have that whole chemistry and biology part that I could do forensic science if I decided that's what I want to do. As well, I'd have the engineering part and the math part if I wanted to.

As a senior in high school Carla's choices were AP Statistics and Multivariate Calculus. Many of her friends took both of these courses, but she wanted to take a science class, so she limited herself to AP Statistics. She noticed that statistics was often required in most college programs of forensic science so she opted for that in her background. Carla thought that AP Statistics was quite easy for her and only recalled having a question about the content on two occasions during the course. She thought the whole course could have been learned in less time and that it got repetitive and boring. During

the days that class was repetitive and boring, she wrote her agenda and sent text messages on her cell phone to her friends. She noted that this behavior was not condoned. Her grade in the course was 100%.

To complete the interview, I turned the discussion to Carla's definition and measures of success.

> I did think I was successful. I think that because I was able to get all As, but also to understand. I can look at other problems that I haven't ever seen before and I can figure out what I am doing. If anyone else needs help, I can figure out what I'm doing. Even if I haven't looked at it for three or four years, I know exactly how. Like, my brother; I can look at his math book and I can go back and say, "Well, this is what are you supposed to be doing and this is why." I can teach it to him. I can tell exactly how to get it and why and what he is going to need to do. Although I did get As, I actually learned what I was talking about.

I found her last comment to be an odd one. It was as if she acknowledged that it was quite possible to make an A in a course without actually learning anything, and she was pleased that she had managed to accomplish both. When pressed about whether the grades or the understanding carried more weight in her definition of success, Carla thought that the learning carried more weight.

> I think learning, like being able to explain it, has a higher weight than getting an A. When I had the Analysis, at the end of the semester, it was actually learning, the most I have ever learned in my life. I didn't even care; like, I cared that I was getting a B, but I was actually learning. So I wouldn't have been mad if I had a gotten a B because I actually knew what I was talking about. Even if I had gotten a B, I was going to be glad that I took the class for the next year.

She attributed her success to her own motivation to understand things and to do well. She described herself as persistent, hardworking and curious.

> I am a person who hates not understanding what's going on or how to do it. Even one problem on the homework; if I can't do one problem.… Most people say "Okay, I did it all." I hate not understanding one problem. I go in and I ask about one problem even if it doesn't matter. I think it is just

> my personality that I want to do well. I am very persistent and I am hard working, curious about things, like to know why.

Carla also attributed her success to the support of her high school teachers. Of the teachers, she knew that they all wanted the students to do well. They were willing to stay whenever you needed them. She said that they gave the students their home phone numbers and email addresses and students knew that if they ever needed to, they could just call.

> You could tell by the way they, like, if you didn't understand something, they'd make sure. They look you in the eye because they could tell if you didn't understand by they way they were focusing on you. They make sure that everyone kind of understood. Sometimes she'd move on but you would go see her after class and she was willing to stay there. She would sit right next to you like this. She wouldn't give up on you as long as you wouldn't give up on yourself. Even if you did get discouraged, she would push you a little bit father. She didn't do it so much in words, but her actions. She'd give you little study sheets or stuff just to help you. She'd make you explain it to her. You could tell that she wanted everyone to understand.

Carla also attributed her success to parental support. She shared that her father was an engineer and had majored in mathematics. She said that he was mostly able to give guidance about what she should do when she asked for help but when she was taking Analysis, there came a point when "he just didn't have any idea." Then he would sit with Carla and together they would try to figure things out.

She said that her parents were supportive with their attitude and that they never "forced" her to get an A. She never felt any pressure from them but acknowledged that she put pressure on herself. I was curious about her parent's reaction when she would cry about math. Carla acknowledged that she could get a little too emotional and her parents would encourage her to keep some perspective.

> Most of the time they would say, "All right, don't worry about it." My mom would say, "Okay, calm down. It doesn't matter." Most of the time it

> was "doesn't matter, we know you care, we know you are trying your hardest. Really, keep your head and do fine. Everything will be alright."

I told Carla that when I called her home to contact her that her father had shared that she was President of the Math Honor Society. She laughed.

> I did the Math Honor Society because I was ready to get involved. It looks good on college stuff. It was just something I could do; and volunteering and helping out. I did that in my junior year. Someone nominated me for President. I got it.

Janine

I conducted the telephone interview with Janine on a Saturday in early June, shortly after her graduation from Eastside High School, the same school Carla had attended. She said that she had taken a math course, AP Statistics, during her senior year in high school. The courses she took during high school were Honors Algebra II in ninth grade (grade of 94%), Honors Analysis in 10th-grade (grade of 94%), AP Calculus BC in 11th-grade (grade of 95%), and AP Statistics in 12th-grade (grade of 99%). She was satisfied with the experience of participating in accelerated mathematics during the previous six years because she thought that without it she would have been bored. Janine felt that the fact that she had the opportunity to take Calculus and Statistics, receive college credit for them, not be bored and experience more of a challenge most significantly affected her sense of satisfaction with this path of study.

She shared that her most memorable experience associated with the previous years of math study were that she had the opportunity to take high math classes, be better prepared for college, that she had the best teachers in the high school, was surrounded by the top students and she got to work harder. She agreed to meet me on the following Monday for lunch at Einstein's Bagel Shop.

Janine was a tall, attractive girl with a large, athletic build. She had brownish/sandy hair and I was struck immediately by her confident manner of speech and demeanor. She was the only one of all the participants that took me up on the offer of lunch. We ordered our lunch at the counter and settled at a table next to the window that bordered the street. She impressed me with her frequent smile and easy laughter as someone with a positive outlook and a good sense of humor. She began her recollection of her math learning experience by stating that she knew she was ready to take high school math courses in seventh grade because she had taken Pre-Algebra in sixth grade and was not challenged at all. She also immediately shared that when she took Geometry in eighth grade, she and her peers did not believe the teacher was prepared to teach it. This lack of a good background in geometry hurt the group throughout high school and she said, "I never learned the basics." Janine explained that it was not necessarily the teacher's fault, but that the teacher was not experienced enough with geometry and that "I don't think she knew what she was getting into with us." Janine and five other girls took action near the end of the eighth grade year by taking their problem to the Principal of the school.

> Actually we went to the Principal about it to talk to him. We felt like our teacher would stand up there at the overhead with our books open. She would read us notes out of the book and then she would tell us to do the problem. Then we would ask her question and she wouldn't know how to answer them. Actually we had talked to the Principal about that for the students for next year.

Janine found the Principal open and supportive of the girls but they had not acted early enough in the year to affect their own experiences. He did try to help the teacher understand that the students were having problems. Though she said she wished things had gone a bit smoother, it was a good experience for her and that she was glad that she

had done it. The group of girls coped throughout the year by organizing themselves into groups and teaching each other.

> I know at the beginning of the year we talked to her, our teacher, a lot and tried to get her to understand our side and how we felt. It pretty much became like a class and we got into different groups and helped each other learn it. We felt like we were teaching ourselves almost, which is unfortunate. I think we all ended up doing pretty well, but it was just a very frustrating year. I hated it at the time. Really did. I guess because they had told us all these positive aspects of this program and we just started into it and we felt like "What are we getting into?" This isn't what we had signed up for. We were supposed to be taught.

Janine recalled having more homework that she was previously accustomed to but thought it helped her learn to manage her time. "By starting it early, by the time I got to high school I could organize my time better. I didn't get that from my other classes in middle school because they were the basic run-of-the-mill middle school classes." She described a routine that she established where she always did her homework before anything else, even though she was very active in basketball and other sports.

Janine recalled that everyone she knew made it through the class in eighth grade but that perhaps 2 or 3 out of the group of 20 students that started in the program dropped out of it in the middle of the ninth grade advanced classes. She said they dropped out of the program because they did not think they were prepared and they did not have the basics.

In ninth grade, Janine took a course called Synergy Honors Algebra II. This was Eastside High School's version of a gifted honors math course. This school was interesting in that it further divided a group of very talented mathematics students into yet another strata of giftedness. To be an Honors student was a distinction of giftedness or achievement. To be a year younger than most and in an Honors class was a distinction of

giftedness, talent, and achievement. Yet this school made another cut of the gifted from those already at the top and created a Synergy class.

> When I got to high school, there were students from the other middle schools. When you were in middle school you had your geometry class. Then in high school they split up into Synergy, Algebra II and regular Honors Algebra II. So maybe about five of us went into Synergy and everyone else went into the regular Honors Algebra II. So it was mostly new people.

Janine made As (95% and 92%) during her two semesters of this class. She had the same teacher for both 9th and 10th-grade math classes and described the teacher as "the best teacher I had in high school. She was so enthusiastic about math. I'd be excited to go home and do a half hour of math problems, whereas the year before I would absolutely dread it." This teacher helped the students catch up on bits of geometry and bridge the geometry deficiencies. Janine recalled that the classes were small with only 16 or 17 students in them and that these were fun and challenging days.

> The students that went into the regular Honors Algebra II class had a hard year. Their teacher left in the middle of the year and they had supply teachers all year long, so they definitely weren't ready to teach Algebra II. I had a lot of friends in that class. I think the year was as frustrating for them as it was in eighth grade because they suffered the same thing. They weren't getting taught. They were teaching themselves because they had substitute teachers all the time.

The topic turned to peers and the composition of classes in high school. Janine said she got to a point where she was anxious to meet new people. She acknowledged that when a person is "stuck" with the same people, in classes again and again with the same people, that there are always some people that he or she wishes weren't in the class and he or she does not get a chance to meet new people. Because she had Synergy status, she was in several subjects with the same people.

> I would go to science with them, and I would go to social studies with them and I would go to math with them. Then I'd think, "Let's get some

> new people. I want to keep my old friends but I'm ready to branch out a little bit."

Janine said that this desire for meeting new people was centered on the social aspects of meeting new people, not a need for increased mathematical challenge or ideas.

> Social. People in these classes were definitely very bright in mathematics. I work hard in these classes but I'm not one of these people who went into the math class and knew all the material. And there were kids like that. They brought up things that I would never in my life think of. It was another way of challenging myself I guess.

In 10th-grade, Janine's math course was Synergy Honors Analysis. She again made As (93% in each semester) and described it as the hardest math class of high school because it required "very in-depth thinking." AP Calculus BC in the following year would be rated as easier.

> I had always liked to replace things in the problem and solve for x but now it was why and how. It was very challenging. Very critical thinking. Critical thinking that I hadn't gotten anywhere else before. It was a tough year. Lots of homework. I probably spent an hour a night doing homework. If I didn't have homework, I was probably figuring out what we had done in class that day. Like before, I didn't have to give up anything, it just helped me manage my time.

It sounded like quite a load as I listened to Janine describe the activities and schedule she was managing.

> In the fall I had two hours of cross-country practice every day after school. Then I would go to two hours of drill for the tennis team. I would get home at nine [o'clock] at night to start my homework. I'd start my homework at school at lunchtime. I never felt like it was too much. I wasn't ready to give up my athletics for math.

AP Calculus BC in 11th-grade was an easier and more slowly paced class. In the Calculus class they could spend three to four days on a topic, whereas in Algebra II only one day was spent on a topic. She acknowledged that possibly the Analysis work served as the building blocks for Calculus, making the Calculus easier to learn. Janine made As

in AP Calculus BC (97% and 92% in both semesters) and she made a score of 5 (out of a possible 5) on the AP Calculus exam. She said that she might take Calculus or Calculus II again or no math in college. She was not sure because she was not going to be a math major and had done so well on the AP exam. She felt that the previous experience in it would be helpful.

Janine recalled that her teacher for AP Calculus BC was a very good teacher. He was supportive, at school every morning to give help, always answered every homework problem until all the questions had been exhausted and spent any amount of time needed on any topic. Preparing for the AP exam was a good experience for her as she had never before had to take a cumulative exam.

> Before I would choose what to study for the test. I could forget it and it would never bother me. But now I had to retain it all and go back for a couple of months before the exam and start reviewing it. So that was a good aspect of it.

As a 12th-grade student, Janine took AP Statistics and made As again (97% & 100%):

> That class was a blast. It was so much fun. I think it was really neat to get away from the basic math that we were taking, like equations and derivatives. Instead we were doing logic, real life data, which was really neat. Like, "Okay, I'll actually use this in life." When I had calculus, I thought I'd never use this.

Janine scored 770 on the math portion of the SAT. She attributed her high score to the time that her 10th-grade and 11th-grade teachers spent on prepping the students for the SAT. In both grades this was accomplished during class time because the class was normally fast-paced. "That was another benefit to being in a class like that. You were able to go fast-paced so we'd have time to take a week out and do SAT prep questions." She described many of the students who participated in this course of study as being

frustrated and nervous that they did not get an Honors extra credit when they took the advanced high school courses in middle school. Many worried about valedictorian status.

> For a lot of people that really bothered them. They felt like they were taking an Honors class in middle school yet they weren't getting any Honors credit. That was one thing that a lot of people didn't like. Back in middle school they told us it will bring down your GPA when we first started the program. For me, I was going to take the credit and get my 4.0 and that's all I really cared about. But for a lot of people that's their goal. There are some very competitive high school students out there.

I turned the conversation towards success. I asked if she thought she was successful and how she measured success. Janine expressed that she thought she was successful.

> Yes, I feel that I was successful with this program. I made all As. If I had made Bs that would not have meant that I was not successful. It helped me with my time management, my analytical thinking, it helped me learn a lot about life lessons, a lot of things that will prepare me for next year and for many years to come. In that way, I think it was a success. I learned a lot and it forced me to focus because I have never really been challenged. Things came easy to me. I wouldn't have to study for a test. I would do my homework, but I wouldn't need to do it. I think this helped me to realize that things can be a little harder which will be beneficial next year.

She went on to say that the high school teachers contributed to her success. She thought that she had been fortunate to have the best teachers in the high school. She knew they were the best because "the best teachers teach the best students." She felt that the teachers who teach and work with gifted students had to be special.

> The teachers are going to be the ones who can handle kids like that. It takes a special teacher to do that. It really does. You can't just have any teacher in there with these kids. I couldn't do it. A lot of these kids know more going into the class than a lot of the teachers going into the school now. And to get somebody who can handle kids like that and not get nervous? There are kids in my class who want to show they know more than the teacher.

Janine also attributed her success to her own work ethic. That work ethic is characterized by a commitment to quality and by tenacity. She also thought she learned

balance and time management from the needs that arose from the challenges she faced during the experience. She described her work ethic:

> I am one of those people who will keep at something until I either succeed at it or finish it. I pride myself in turning in work that I feel is quality and I'm proud of. I'm not one of those people who will flop something together at midnight the night before it is due and turn it in. I've learned to do things. If I get an assignment that is due in three weeks I've learned to do it the first week because I know that I'm going to get more stuff later and I might as well do it while I have time. I'm definitely not a procrastinator. I just like to be proud of what I do and if somebody reads something I wrote or if I am going in to take a test, I don't want to take it without knowing what I'm doing. I feel it is not fair to the teacher and it is not fair to myself. If they put in their job to help teach us, the least I can do.

Janine wondered if I had noticed that many gifted students, more so than any other group of students, were procrastinators. She described the scene of several of them up all night long, pulling an "all-nighter" over something that was assigned three weeks prior. I had to laugh to hear a gifted student describe her peers as procrastinators as this certainly was a trait that I had observed in some gifted students. Finally she attributed her success to her parents. They didn't pressure her about grades and they knew her well enough to know that she was working to succeed. Her father, an accountant, would sometimes actually help with the math. She reported that her mother hates math but offered other types of support during rough times.

Janine went on to the University of Missouri-Columbia and majored in Sports Journalism. After reviewing her transcript of the interview she wrote to me.

> I don't know if this will help you out at all, but I have been staying busy with math in college. As I told you, I am a journalism major and with the credit I received in high school from calculus and statistics, I did not have to take any math courses in college. But after a year of no math, I actually missed it. So this August I became a tutor for students taking finite mathematics. I hope to continue tutoring for my remaining years of college, since I am loving the job. Next week I actually leave for France,

> where I will be studying for the next four months, but when I return in the fall, I will resume the tutoring.

Lisa

Lisa's telephone interview yielded the following information. She had taken a math course as a senior, AP Statistics. In ninth grade, she had taken Honors Algebra II (made an A in the course); in 10th-grade, Honors Analysis (grade of A); in 11th-grade, AP Calculus AB/BC (grade of B in each); and in 12th-grade, AP Statistics (grade of B). She made 5s on the AP Calculus tests. She felt that the thing that most significantly affected her sense of satisfaction with the accelerated path of study was that she was "never bored, which is good." Her strongest memory of the experience was that Calculus was a huge challenge but she had a great teacher for it. Her interview was set for 11 a.m. at a neighborhood, open-air shopping center. It had a bookstore where we planned to meet.

Lisa and I met outside the bookstore. It was a comfortable, pleasant day, and we decided to sit outside on a park bench. She had just graduated from Crescent High School and was leaving the day after the interview for a summer trip. She was a pretty young lady with dark brown, curly hair. It was pulled up and back, piled in curls on top of her head. She was short in stature and shapely. Most notably, she seemed vivacious, smiling and laughing easily and contagiously.

Lisa began to share her story beginning with compliments for her seventh grade Algebra teacher. She said that algebra came easy to her.

> I had a good math teacher. She knew what she was doing. She wasn't afraid to kind of goof around if that was what we need[ed]at 12 years old. But we always got things done. I liked the class, I liked the people.

Her class was very small with only 12 or 13 students and she expressed that she was still friends with them now because they had all been in the same class with the same people for years. She made a grade of 94% in the course.

In her 10th-grade survey she had indicated that she hated Geometry but in talking about it now, two years later, she did not say much about Geometry except that it was a bit harder than Algebra and that she was not much of a visual person. She said that there was not anything memorable about those experiences and she had no recollections of anything feeling highly impossible or socially challenging. She had the same teacher and same peers for both Algebra and Geometry courses.

Things changed in high school because of the larger classes, older peers, and a different teaching style. She described feeling intimidated. Her freshman math class, Algebra II, had both sophomores and juniors in the class. She thought that the Algebra II teacher watched out for the few freshmen and protected them from the older students.

> She made sure we grouped together. I think she kind of liked us more than she liked the other kids. We were like her little babies, I guess. I mean it was different. It was a bigger class than I was used to and I took a lot more notes. There was not so much hands-on or one-on-one learning. There was a lot more looking at the chalkboard and figuring it out. I remember not doing so much homework in that class. I wasn't a fan of homework and homework checks.

Lisa elaborated on her view and approach to homework. Mostly she felt that if she understood something that she should not be required to do homework and therefore she did not. This did hurt her grade and caused her stress near the end of the course. Because she had to make up the losses of the homework credit toward her final grade, she made herself study for 11 hours for the final.

> That class taught me how to do high school because I came to the final and had like an 88. I had to get a 99 on the finals to get an A. We had our bonus points for turning in our tests and I think I got a 96. I got a 100 total

> on the final. I got an A in the course. It was very rewarding. I studied for a total of about 11 hours for that final. But I learned to study. I never had to study before.

I asked her if that was true of just math classes or other classes. She said that she had never had to study before this occasion in any class. She indicated that she had always made As in courses throughout her school years by going to school each day, going home, and coming back to school the next day. Nothing else was required of her to excel. She acknowledged that learning how to study was something that she needed to learn and experience before she got to college, as she didn't imagine that she'd just be able to go to class and get good grades. As a graduating senior, she said that she could still do exactly that in some classes.

In 10th-grade, Lisa took the Analysis course. She was again intimidated, this time because she had heard her friends "whine about how hard it was and how impossible it was" and her good friend was failing the course. The source of intimidation was that this friend was someone she considered an intellectual peer, someone who was "right up there with me was not doing so well." Their teacher for this course used a teaching style different from what Lisa was accustomed to, and she wondered if it was not hard to adjust to.

> Basically you have homework and you would do it because that was the only way you really learned anything and you came in the next day and ask questions on it, which usually took about half the period to go over all the questions and then she'd give you a brief description of what the next section was without really explaining it. There weren't many examples. You looked in the book, you see the questions, you tried to read and tried to figure it out. And if you can't, we come back the next day and we'll talk about it. Do it before I teach you. If you're wrong I'll fix it." Which I can do if I want and I did. I didn't like it very much because it is easier for me to be taught the concept, but it did force me to do the work. I felt like I was struggling through a lot of that class but I did fine. I think I got a 91.

Lisa described her own behavior throughout this course as “self-teaching” by doing the homework and reading the book. Although she said that students in the class complained about it frequently, Lisa did not blame the teacher for having a different style. She thought that in high school one would always encounter teachers with different styles just because a student experiences so many different teachers and no one teaches the same way. For her, this experience came in her math class.

Lisa’s favorite teacher was her AP Calculus teacher. She took both Calculus AB and BC with the same teacher. She said this teacher wrote college recommendations for her. She described his style of teaching as one that provided lots of hands-on experiences. Interestingly, Lisa experienced great difficulties in her Calculus classes with this favorite teacher, who could provide reasons to learn, ways to apply the learning, and hands-on experiences.

> I think it was just the math. It took me a long time for the math to click. From the very first lesson, I didn’t get limits and so it went on to cause more problems because I didn’t really know how to do a limit. It got better when we got to use our calculators because I understood the concept, but I couldn’t always remember the formula or the way to write it down. Eventually, the concepts, at least for AB clicked. I think I got an 87 in AB and I got a 5 on the AP test. It’s the only class I ever cried in. I cry when I get really frustrated if no one will help me. There were a lot of very bright kids in there and they got it just like everything else. I would say, “Hey, help me” and they would still be doing the work and I would get upset. Mr. --- would say, “Lisa, get up and leave and go to the bathroom.” He liked to tease me about it.

Lisa continued into AP Calculus BC, where it was even harder. She shared that she had struggled in that class, went into the final exam with a 78% course average and finished the course with an 80% that she had “struggled a lot” for. She explained that she got through it but wasn’t sure how much she had learned until she got her AP test scores back. I asked her for clarification about her scores three times.

Lisa: I got 5 (out of possible 5) on that AP test when I got my scores back.
Me: That was on the real AP test, not one of the practice exams?
Lisa: Yeah.
Me: Not the practice exams.
Lisa: No. Got 4s on most of the practice exams.
Me: You got 5 on the AP exam.
Lisa: On both parts of the AP. It clicked. It clicked like three weeks before the AP test which didn't do me much good because by then I had like a D. But it happened.
Me: Fascinating. You got 5s on the AP exam and three weeks before you had a D? You couldn't have done any better than a 5.
Lisa: Yeah. I do well under pressure I guess. I was happy with it.
Me: You should be.
Lisa: I had just got my wisdom teeth out and had my mouth full of gauze and I was in my driveway jumping up and down [when she received her AP score in the mail]. Dad had no idea what I was saying. It was really hard but I could study and I could study and I just wouldn't get it. It sometimes just doesn't happen.

At this point in the interview, I was stunned and nearly speechless. This young lady's story was quite amazing. I was curious about what she had learned about herself in the process of going through this experience. I asked, "So what do you think you know now about that process or about yourself?"

> I'm not invincible. It's easy when you're younger and you think "I'm so smart. I can get As in classes and not do my homework." Then along the way you learn, "Well, maybe I'll have to work a little. That's not so bad. I don't have to study so much. I can study just a little." And I go through a class like that and I was "No matter how much I study, no matter how much homework I do, I still don't get it. I'll eventually get it." I'd get upset about it. I don't get upset now. It's not worth getting upset over. Math just isn't that important.

I wondered how she coped and got through this very difficult period. She said she had no other options and that she had a good friend who was in this class with her, going through the same frustrations and difficulties. They were totally frustrated, occasionally crying in class and leaving together to go to the bathroom to cry and decompress.

> I guess that I'm just determined. There are certain people who . . . I guess I have always been good at academics. I can be good at that and I didn't not

> want to be good at it. I didn't know what I'd be good at then. I had to be good at something and that was it. That was what I was going to do.

I asked if her parents knew her level of frustration and if they did anything to support her through the experience. She revealed that her mother had died when she was little and that she had no brothers or sisters. "It's just me and my Dad and we are like friends. It's not very parentish."

> My Dad knew that I was frustrated. I wasn't distressed. It was only for the moment. Leave the class and then I'd be okay again. It wasn't the concept that "Oh, I'm going to fail Calculus." I had other things to be thinking about, other things to be doing once I left class. When I left the class it was over. It was just while I was sitting there and everyone else was going on and I didn't know what to do. I had to keep going to class and I had to keep trying not to fail. I did it. I don't know. (Laughs)

As I listened to her story I wondered out loud to her whether it was all worth it and if she would have preferred to have not experienced this early challenge. I explained that one of the reasons for initiating this path of study for very able math students was to ensure that they had appropriate challenges in school and that the first time a challenge came along was not after they had already gone off to college, with possibly less support, attention, and advice from caring family. But in listening to her story, this challenge to her seemed a bit extreme.

> It was worth it. If I hadn't gotten such good grades on the AP tests, it might not have been worth it. The fact that I get some ridiculous amounts of credits for my AP courses, it's worth it. I get almost a semester of classes for the two math classes. That's amazing. That was worth it. But it still stunk. I would have rather it be easier and still done well, but it was worth it. Here I can take just 12 credits in my fall freshman semester and can take 12 in the spring. If I have a hard class I always have a couple extra credits. I'll be able to go slow if I need to.

She felt that all the struggle and hassle would ultimately buy her some time. She was enrolled at Boston University on a partial scholarship.

Surveys

The six students who were interviewed are a subset of 62 students who completed surveys in the 10th-grade. Following are the tables from processing of the data from all 62 of the returned 10th-grade surveys. These data included the six students whose interviews are the subject of this research, although in some tables in this section the interview participants' data is summarized separately from the data of the other survey respondents. Table 3 is a comparison of means for the grades that the surveyed students made in their courses, Algebra I, Geometry, Algebra II, and Advanced Algebra/Trigonometry or Analysis. The means for the grades in the courses decline with each successive year, then increase slightly (less than 1%) in the fourth year. The range of the final course grades gets larger each year.

As shown in Table 4, there was a decline among the surveyed students in the satisfaction rating with Geometry in the second year of the program. The rating scale spanned from 1 (*negative*) to 4 (*positive*), so I interpret a rating of 2 to be *a little negative* and a rating of 3 to be *a little positive*. The modes for levels of satisfaction were higher than the mean for every course. Note that the range in the first year is narrower than the ranges in the successive years. In the Algebra course satisfaction ratings, not one single student reporting rated it as 1 (*negative*). However, in each of the successive years, the ranges span the full scale of 1-4.

Table 5 displays both the interviewed and surveyed groups of students' satisfaction with the eighth grade Geometry course. The interviewed students had expressed dissatisfaction with their Geometry experiences. However, of the students who responded to the survey but did not participate in the interviews, over 65% rated their

Table 3

Comparison of Grades Obtained in Courses

Grade	*N*		*M*	Mode	*SD*	Range
	Valid	Missing				
7th	47	15	93.40	96	3.797	15
8th	48	14	91.90	94	4.333	19
9th	45	17	89.56	90*	6.953	28
10th	42	20	90.12	93	6.485	29

Note. * Multiple modes exist; the smallest value is shown.

Table 4

Satisfaction with Experiences in Courses

Experience	*N*		*M*	Mode	*SD*	Range
	Valid	Missing				
7th	61	1	3.34	4	0.793	2
8th	61	1	2.85	3	0.910	3
9th	60	2	3.30	4	0.926	3
10th	61	1	3.28	4	0.951	3

Geometry experiences as more positive than negative. Because the interviewed group also indicated they had difficulties with Analysis, this same comparison was reviewed on the topic of satisfaction rating with Analysis.

Table 5

Means of Satisfaction with Geometry (eighth grade)

Descriptor	Frequency	Percent	Cumulative Percent
Interview Participants (*N* = 6)			
Negative	1	16.7%	16.7%
A little negative	1	16.7%	33.3%
A little positive	4	66.7%	100.0%
Positive	0	0.0%	100.0%
Survey Respondents Excluding Interview Participants (*N* = 55)			
Negative	4	7.3%	7.3%
A little negative	14	25.5%	32.7%
A little positive	21	38.2%	70.9%
Positive	16	29.1%	100.0%

As shown in Table 6, approximately 84% of the students responding to the survey but not participating in the interviews rated their satisfaction with the 10th-grade Analysis course as some degree of positive. Two-thirds of the interview participants did likewise.

Table 7 shows the frequencies of responses from all surveys to questions about whether there were any positive benefits or negative effects. Over 90% of the students indicated that they believed there were some positive benefits to their participation in the program. From the very same set of students, almost 59% of them said that there were some negative effects from their participation.

Table 6

Means of Satisfaction with Analysis (10th-grade)

Descriptor	Frequency	Percent	Cumulative Percent
Interview Participants (*N* = 6)			
Negative	0	0.0%	0.0%
A little negative	2	33.3%	33.3%
A little positive	2	33.3%	66.7%
Positive	2	33.3%	100.0%
Survey Respondents Excluding Interview Participants (*N* = 55)			
Negative	5	8.9%	8.9%
A little negative	4	7.3%	16.4%
A little positive	15	27.3%	43.6%
Positive	31	56.4%	100.0%

Note. *N* = 55.

Table 7

Frequency of Responses to Positive Benefits and Negative Effects

Response	Frequency	Percent	Cumulative Percent
Positive Benefits			
No	4	6.9%	6.9%
Yes	54	93.1%	100.0%
Negative Effects			
No	24	41.4%	41.4%
Yes	34	58.6%	100.0%

Note. *N* = 58.

The statistics in Table 8 describe the students' ratings of the mathematical backgrounds obtained in the seventh and eighth grades, as preparation for their high school mathematics courses. A majority of students rated themselves as strong or very strong in terms of their algebra backgrounds, and a majority of students rated themselves as strong or very strong in terms of their geometry background. Most of the students believed they were prepared for the accelerated program coursework of high school.

Finally, Table 9 reports students' responses to the question, "How would you rate your enthusiasm and enjoyment of mathematics at this time?" Almost two-thirds of the students responded with a 3 or 4, indicating a positive level of enthusiasm (as opposed to dislike) for mathematics.

Table 8

Ratings of Algebra Backgrounds and Geometry Backgrounds

Response	Frequency	Percent	Cumulative Percent
Algebra Background			
Very Weak	0	0.0%	0.0%
Weak	4	6.6%	6.6%
Strong	25	41.0%	47.5%
Very Strong	32	52.5%	100.0%
Geometry Background			
Very Weak	7	11.5%	11.5%
Weak	15	24.6%	36.1%
Strong	23	37.7%	73.8%
Very Strong	16	26.2%	100.0%

Note. $N = 61$.

Table 9

Ratings of Enthusiasm for Mathematics

Response	Frequency	Percent	Cumulative Percent
Extremely dislike	3	4.8%	4.8%
Dislike	18	29.0%	33.9%
Enthusiastic	25	40.3%	74.2%
Extremely enthusiastic	16	25.8%	100.0%

Note. $N = 62$

Although it is good news that nearly two-thirds of the surveyed students described a positive level of enthusiasm for mathematics after four years of study in the accelerated program, it is always a concern for any student who is no longer enthusiastic or may indeed dislike mathematics after the experience. In this case, one out of three surveyed students expressed a level of dislike for mathematics. This is unfortunate.

CHAPTER 4

THEMES AND TRENDS

The themes that first and most obviously presented themselves in the data were shaped by the participants' responses to the evolving interview questions. They are (a) the courses the students completed, (b) students' postsecondary educational plans, (c) definitions of success or satisfaction, (d) the factors contributing to their success (e) benefits derived from participation, and (f) negatives associated with the experiences. Other themes emerged during the interviews and they are (a) students' descriptions of themselves, (b) levels and sources of challenge and ease of the experiences for themselves, (c) experiences of peers. In aligning those themes to research literature, many can be linked to motivation and attribution theory, which are closely intertwined. These include definitions of success or satisfaction, factors contributing to their success, levels and sources of difficulty, coping with challenges and difficulties, positive and negative associations, and some interactions with peers. A discussion of each of the themes follows.

Courses Taken

All of the students interviewed completed the courses that were expected on this path of accelerated mathematics up through AP Calculus. That is, each took Algebra I in seventh grade, Geometry in eighth grade, Algebra II in ninth grade, Advanced Algebra-Trigonometry or Analysis in 10th-grade, and AP Calculus in the 11th-grade. However, the instruction within the courses varied for each student. In some schools these courses

were accelerated for them simply because they were taken a year earlier than most advanced students would normally take them. For example, traditionally an advanced student would take Algebra II in the 10th-grade and all of these students took it in ninth grade. In other schools not only was the student taking a high school mathematics course a year earlier, but the course had the added demands of being an Honors-level course. An example is Honors Algebra II for ninth grade students. Honors-level courses generally imply that the pace and rigor of the course are increased over that of the regular course and students are awarded Honors-level quality points to their grade point average for the additional expectations. In other schools another layer was added to the Honors level. Synergy Honors classes were formed for the advanced students who were also identified as "gifted and talented." Some students took Synergy Honors Algebra II in the ninth grade. This meant that the students were taking a high school course a year earlier than advanced students had previously taken it, that the Honors distinction picked up the pace and required a higher level of performance and rigor, and that the Synergy level further increased the depth, rigor, and scope of the courses.

The courses that the students took following AP Calculus in the 11th-grade varied greatly. Some took no mathematics course at all and filled the math space in their schedule with music and track. Two of the three male students were in this category, and they did not, as 12th-grade students, take a mathematics course (a course with a "math" prefix). All three of the female students took a math-prefix course in the 12th-grade. The two young men who did not take a demanding mathematics course senior year took courses that required the use of mathematics, such as AP Physics and AP Economics. The other four students took mathematics courses such as AP Calculus BC or AP Statistics

during senior year. Of the students interviewed, if they took math as seniors in high school, their course selection included but was not limited to AP Statistics.

The predictions that each participant made in 10th-grade about what he or she would take as a junior and senior were accomplished with one exception. Darren predicted that he would take Calculus and Statistics as a junior and senior. He did take Calculus but did not take Statistics. He reported that he was "worn out with math." He took AP Physics as a science class and took track in his math slot. Robert predicted he would take Calculus AB and BC as a junior and senior. He did. He also took AP Statistics.

In 10th-grade, Gregory predicted he would take Calculus AB and BC in his junior year and would probably take a college course in joint enrollment as a senior. He did complete through AP Calculus BC, and he did enroll in courses at the college level. He took four courses through joint enrollment with a college during his senior year but none was a mathematics course.

All three female students correctly predicted the courses they would complete in their junior and senior years. Janine predicted she would take AP Calculus as a junior and AP Statistics as a senior. Carla had predicted she would take AP Calculus BC as a junior and AP Statistics as a senior. Lisa predicted that she would complete AP Calculus AB, AP Calculus BC and AP Statistics.

According to McLeod (1991), the literature on differences in attributions of female students and male students in mathematics has provided some of the most consistent results on the affective domain: "Males are more likely than females to attribute their success in mathematics to ability. . . . Females tend to attribute their

successes to extra effort more than males do…" (p. 65). The question this raises is whether female students continued to take courses in 12th-grade because this was a version of "giving extra effort" or whether there other reasons for their continued participation in math classes.

The grades in the courses were not verified against grade sheets or report cards, but the grades the students attained in Algebra II and Analysis were consistently reported in both the 10th-grade survey form and their recollections provided during the interview at the end of 12th-grade (see Table 10). Table 10 shows the grade the students reported in their courses on the 10th-grade survey, and the grades they recalled during the telephone interview at the end of 12th-grade. When they completed the survey in 10th-grade, they had not completed the course they were in and therefore did not know their final grades. Darren left this section blank, and Lisa's grade was accompanied by "so far."

Postsecondary Plans

All of the students' plans following high school graduation involved higher education, and all of the students were accepted and enrolled in college or university study following high school graduation. None were immediately entering the work force. Their choices for major area of study at the university level included Music Composition, Recordings Arts and Science, Sports Journalism, Mechanical Engineering, Marine or Nuclear Engineering, Biomedical Engineering, and Music Business. Three of the six interviewees' choices of major area of study were related to engineering, although they were all different types of engineering. One male student and one female student made choices related to music.

Table 10

Students' Reported Earned Grades at 10th-grade-level and at 12th-grade-level

	Darren		Robert		Gregory		Janine		Carla		Lisa	
Course	10	12	10	12	10	12	10	12	10	12	10	12
Algebra I	88	88	A		99		97		93	94	94	
Geometry	92		A		94		96		95	95	93	
Algebra II	A	A	A	92	96	95	94	94	102	100	90	A
Analysis	---	B/A	A/B	90	93	93	94	94	83	90	89	90
Calculus AB	n/a	A	n/a	96	n/a	86	n/a	95	n/a		n/a	B
Calculus BC				96						92		B
Statistics	n/a	n/a	n/a	n/a	n/a	n/a	n/a	99	n/a	100	n/a	B

Note. Student's reported grades at 10th-grade (10) were obtained from the survey. Students' reported grades reported at 12th-grade (12) were obtained during telephone or in-depth interview at the end of 12th-grade. District grading scale: A=90-100, B=80-89, C=74-79.

At the end of 12th-grade, just before entering college, four of the six students were on track to major in the field they chosen as 10th-graders. In the 10th-grade survey, Darren predicted that he would major in Marine Engineering or Computer Engineering. His interview revealed that he was still on track with that, as he said he would major in Marine or Nuclear Engineering. Robert's early prediction was that he would major in Pre-Med or Engineering. His choice for major field of study was Mechanical Engineering. In 10th-grade, Janine thought she would major in sports broadcasting or journalism. She, in fact, majored in Sports Journalism. Carla predicted that she would major in Science in college. Her interview revealed that her choice of major was Biomedical Engineering.

Lisa predicted in the 10th-grade that she would major in Marketing. She ultimately majored in the business aspects of music. Gregory predicted that he would go to college, but he did not have any intended plans for a college major. At the time of the interview he had been accepted to Peabody Conservatory of Music to study Composition and Recording Arts and Science.

Definitions of Success

The students who were interviewed all considered themselves successful and satisfied in this program of study and their definitions of success fell into three broad categories. They are happiness, sense of accomplishment and learning. Only one student, Darren, defined success as being inclusive of all three of these categories, and he was the only one to name happiness in his definition of success. All but two students, Lisa and Gregory, included learning and understanding as part of their definitions of success. Lisa and Gregory's definitions of success exclusively focused on accomplishments of some type. All of the students cited the accomplishment of something as a factor of success.

In the category of "accomplishment" they named several types of accomplishments. These were (a) accomplishment of goals, (b) accomplishment of good or desired grades, (c) accomplishment of avoiding boredom, (d) accomplishment of exposure to new challenges, (e) accomplishment of being prepared for desired opportunities and desired colleges, (f) accomplishment of something that he was told he could not do, (g) accomplishment of not being "beat" and not quitting, and (h) accomplishment of receiving a lot of college credit (see Table 11). "From a motivational viewpoint, goals and goal setting are considered to play a central role in self-regulation" (Schutz, 1991). Goal setting influences learning and motivation by

Table 11

Accomplishments as Measures of Success

Accomplishment	Darren	Robert	Gregory	Janine	Carla	Lisa
Goals			X			
Good or desired grades	X				X	X
Avoiding boredom						X
Exposure to new challenges				X		
Being prepared to enter desired colleges	X	X		X		
Of doing something previously denied	X					
Not being "beat," not quitting						X
Receiving college credits						X

providing a target and information about how well one is doing" (Alderman, 1999, p. 88). Alderman outlined the motivational effects of goal setting as follows:

> Goals are cognitive representations of a future event and, as such, influence motivation through five processes (Locke, Shaw, Saari, & Latham, 1981; Locke & Latham, 1990). More specifically, goals: (a) direct attention and action toward an intended target. This helps individuals focus on the task at hand and marshal their resources toward the accomplishment of the goal. (b) mobilize effort in proportion to the difficulty of the task to be accomplished. (c) promote persistence and effort over time. They provide a reason to continue to work hard even if the task is not going well. (d) promote the development of creative plans and strategies to reach them. (e) provide a reference point that provides information about one's performance. (p. 89)

Three of the students, Darren, Robert, and Carla, considered themselves successful because they had learned and understood mathematics. Janine was the only

one who considered learning lessons that she thought would be important to college and life as part of her success definition. She thought that learning to manage time and challenges and how to stay focused were part of being successful. As well, she considered herself successful because she had become an analytical thinker.

Factors Contributing to Success

The research indicates that there are four to five reasons that are typically offered for success or failure. "The research by Weiner initially identified four reasons most frequently given as the cause for success and failure in achievement settings: ability, effort, task difficulty and luck. Subsequent research identified learning strategies as a fifth possible reason for success and failure." (Clifford as cited in Alderman, 1999, p. 25). These reasons are defined as follows:

a. ability – how we rate our aptitude, skill, or knowledge . . .
b. effort – how hard we tried, including time spent
c. task difficulty – how difficult or easy we believe the task to be
d. strategy – the type of strategy use for learning . . .
e. luck – the extent to which we believe luck was a factor (p. 25)

The students each named between two and five factors that they thought contributed to their success with this program of study (see Table 12). For a total of nine factors, the factors they named, are motivation from various sources; parental support; work ethic and own hard work; teachers; competition; personality characteristics; heredity; AP prep and review booklets; and the pace of instruction in high school. Below I discuss the six characteristics mentioned by at least two participants which excludes heredity, prep booklets and pace of instruction.

Table 12

Factors Contributing to Students' Success

Factor	Darren	Robert	Gregory	Janine	Carla	Lisa	∑
Motivation of various types	X	X	X		X		4
Parent support	X	X		X	X		4
Work Ethic or Hard Work	X		X	X			3
Teachers		X		X	X		3
Competition	X					X	2
Personality Characteristics					X	X	2
Heredity			X				1
Prep booklets		X					1
Pace of instruction	X						1

Motivation

Motivation was cited specifically as contributing to success by four of the students. Gregory reported being motivated to attain high grades. Carla said she was motivated to understand and to do well. Darren was motivated by competition with a friend and a dream. Robert said he was motivated to make the most of his time and learning opportunities in school and to be as knowledgeable as possible about math. Though they did not state it as a factor in their success, Janine's and Lisa's interviews revealed that Janine was motivated by a desire to balance both sports and academic interests and Lisa was motivated by a desire to fight back against something that might defeat her self-image.

The literature on motivation includes and is complexly intertwined with many of the aspects that the students named separately, such as hard work, determination, goal setting. Alderman (1991) summarized the variations of the descriptions of motivation:

> A central theme in current motivation theories and research is the focus on developing self-regulated learners. Students who have self-regulation use both motivation and learning strategies (Zimmerman, 1994). According to Corno (1993), self-regulated learners have what is know as *volition*, or the ability to "maintain concentration in the face of obstacles." . . . [It is] described by Brophy (1983) as more than simply doing enough to meet requirements but purposefully engaging in academic tasks by attempting to acquire the knowledge or skill involved in them. . . . Students with a *will to learn* are characterized as believing in themselves and in their ability to think for themselves. (pp. 10-11)

Parents

Parents were named as a key factor by the most of the students in contributing to their success. Much literature regarding parents and gifted students centers on parent interactions with the school and program, and on guiding parents in the role of advocate for their child. Since the parents were not surveyed nor interviewed it is not appropriate to draw conclusions about the parents' view of or interactions with the acceleration program for their students. Therefore it is not possible to know which type of model for school interaction (Colangelo & Davis, 1997, Assouline & Lupkowski-Shoplik, 2003), Type I (cooperation), Type II (conflict), Type III (interference) or Type IV (natural development) they might fit into. Only in the cases of Darren, where he and his parents were not happy that he didn't initially make it into the accelerated class, and Janine, regarding her dissatisfaction with her teacher, does there seem that there might have been any potential for conflict or interference. Darren and Janine did not mention any advocacy role on the part of their parents. Regardless, they both also described their parents as a key factor in success.

Four of the five students characterized the role of their parents in contributing to their success as one of support. In each of these four cases, the students said that their parents did not pressure them to achieve or make certain grades in the courses.

Interestingly, while these four students attributed their success to the support of their parents, not one student in this group described any pressure, ramifications, punishment, or over-involvement from their parents. Nor did any of the participants mention any overwhelming desire to be successful in order to please their parents. The research supports this observation with the following,

> In terms of adolescents' pursuit of their talents, their achievement motivation, and confidence, there is a growing body of evidence that an optimal pattern consists of family demandingness, high expectations, and promotion of independence in the context of warmth and parental responsiveness (Baumrind, 1989; Csikszentmihalyi, Rathduen, & Whalen, 1993; Schmidt & Padilla, 2003). (Colangelo et al., 2004, p. 60-61)

Darren said that his parents encouraged him to go after what he desired and dreamed of. When asked, "What helped you be successful?" Darren's first comment was about his parents.

> I have to say parents. They were very supportive. They definitely talked me into being in that Pre-Algebra class. I would never had been in that if they had not said, "Hey, you want to go in that class? Why don't you go in that class?" So they are the reason why I was there, because of the support I received. . . . When I would say it's too difficult, they would say, "You can drop out if you want to." There was no big deal, no pressure ever to succeed. It all came to me. Really great parents.

Three of the students reported that their parents did mathematics with them. Robert's father did math with him, empathized with him, and counseled him about keeping his perspective when things seemed difficult.

> My parents were really good about math and me. My dad and me, he's a pretty good math student but he wasn't always a good math student. He wasn't the quickest guy all the time and some stuff was totally abstract to him. So he understood if I didn't understand. He'd say, "Do it over. Ask questions." There was never that pressure like [to] get the highest grade. [They said,] "You did you best. Your best is good enough for us. If you get a B or C along the way, if that's your best, that's your best."

Carla's father did math with her. Carla also reported that she received no pressure from her parents to make As. "They never forced me to get an A. They said 'as long as you are trying hard' and they knew I was, so I never felt any pressure. I always put the pressure on myself."

Janine's dad also did math with her and her mother, who "hates math," offered guidance about keeping balance. Janine said that her parents did not pressure her about grades and assured her that they were confident that she was working to succeed. Janine shared,

> They are not the type of parents that if you don't make an A you are going to be grounded. They know that I'm a good student and they know that I'm going to work to succeed, put in the effort that I need to. But my parents have always been there if I need help. . . . They are very supportive. There were times when I was up at 11 o'clock and they would say, "Why aren't you in bed? Stop doing your homework." But they knew that what I was doing was probably best for me. My mom hates math. She does not like math at all. She couldn't help me at all, but they also helped me focus in the beginning. If it was a Sunday afternoon and I wasn't doing anything and I'd want to go outside, they'd say, "Maybe you should get your homework done and tomorrow night you will have a free night." I think a little bit of guidance like that and eventually I was able to develop on my own and no longer would they have to say, "Why don't you start your homework." I'd automatically do it. They were supportive during times when I was having a rough time. During the teacher situation, they'd say, "Don't worry about it. It's just school. It'll pass." I think they thought it was a good life lesson.

Robert reported that he had no pressure for grades from his parents. Darren also characterized the support from his parents as "lack of pressure."

Gregory thought his parents contributed to his success. His statement that his parents contributed to his success centered on the idea that his parents were intelligent and he had inherited a gift of intelligence from them.

> I am sure that a part of it is just being given a gift of intelligence because I know my mom is really smart. My dad wasn't as smart as my mom, but he was also pretty intelligent. Even though we say that everyone is equal, I

> don't agree that it is necessarily true in terms that we have all been given different things when we were created. Some people are going to be really good musicians, some people are going to be really good at math and some people aren't. That doesn't mean that some people are better people. They just have different things that they are good at.

Work Ethic

In response to the question, "What do you think helped you be successful?" Gregory said that a good work ethic was strong in him through the 10th-grade. Talking about the role of hard work and his success, Darren said, "Later on, it was just me working hard."

> My parents, once I got into algebra, they weren't much help any more. It's pretty much myself. I worked hard at it. I didn't want to make any bad grades in it, especially since I'm the one who wanted to be in the class.

Janine replied to the question about what she thought contributed to her success with, "I think my work ethic." In turn I asked, "How would I know your work ethic?" Janine had some definite ideas about it.

> I am one of those people who will keep at something until I either succeed at it or finish it. I pride myself in turning in work that I feel is quality and I'm proud of. I'm not one of those people who will flop something together at midnight the night before it is due and turn it in.

She further elaborated on her work ethic as being committed to quality, being tenacious, and seeking balance in managing her multiple commitments and interests.

Teachers

Teachers were named as contributors to success by three of the students. Carla and Janine both specifically named the high school teachers as supporting their success but Robert thought all of his teachers throughout the experience were talented and knowledgeable. Robert said,

> [I] give a lot of credit to the teachers along the way. Developmental stages are pretty big. I think each teacher was great in putting all the basics together. . . . They all did a great job.

Janine explained, "I think the guidance from my teachers, especially in high school, was very important. I had the best teachers and I had teachers who were willing to help us until we understood what we needed to." When I questioned her about how she knew she had the best teachers, she explained.

> By word of mouth and as you go through high school, you can tell the best teachers teach the best students. In most of my subjects, the teachers who are the most, who have the most to offer students who are gifted and that are a little above everybody else in what they know already. The teachers are going to be the ones who can handle kids like that. It takes a special teacher to do that. It really does. You can't just have any teacher in there with these kids. I couldn't do it.

Janine thought the teachers had to be able to accept challenging students and students who would challenge them, even about the math. She felt that her teachers were up to the challenge, were confident and were competitive themselves.

> [They can take the challenge] and they enjoy it. They enjoy what they are doing. They love math. They are enthusiastic and it rubs off on their students. If the teachers enjoy it then the students are more apt to enjoy it. When you have teachers who stand up there and are just monotone and write things on the board, you are not going to enjoy the class as much.

Carla thought her high school teachers wanted the students to do well. She described one of her teachers.

> She wouldn't give up on you as long as you wouldn't give up on yourself. Even if you did get discouraged, she would push you a little bit farther. She didn't do it so much in words but her actions. Like she'd give you little study sheets or stuff just to help you. She'd make you explain it to her. You could tell that she wanted everyone to understand.

It is clear from the students' stories that even if they did not attribute their success to their teachers, teachers' effects on their students are profound and long lasting. These effects can be both for the good of learning and for the miseducation of students. These

students were keenly aware of the effects that their teachers were having on them and recognized the role the teachers played in teaching, supporting and guiding the students and the instruction.

Personality Characteristics

Almost all of the students named some personality characteristics and attributes that they thought helped them be successful, but generally those came up in association with what they called their "own work ethic" as was previously described. Carla and Lisa also specifically named personality characteristics such as persistence, curiosity and determination as sources of their success, but they did not fold these characteristics into the category of "work ethic" or "hard work" as did the others. Lisa's "determination" was actually determination to hold on to her self-image as a good student and quite possibly not something she might put in the category of "work ethic." She said,

> I guess I'm just that determined. There are certain people for whom academics is— [trails off and pauses] I guess I have always been good at academics. I can be good at that and I didn't not want to be good at it. I didn't know what I'd be good at then. I had to be good at something and that was it. That was what I was going to do.

Her determination was centered on the survival of her self-image. One of her definitions of success was stated as "Not letting it win, I guess, is success." Lisa named a "competitive spirit" as a factor contributing to her success, but her subsequent comments reflected that this competitive spirit was not competition against another person or group, but competition with "it."

> If I had gotten a C in Calculus it would have won. I would probably not have taken AP Stat. I would have probably said, "I'm done, no more." . . . I have never gotten a C and I wasn't going to let it get me.

Carla attributed her success to aspects of her personality, like persistence, curiosity, desire for completion and being hardworking. Asked directly, "What do you

think contributed to your success?" she replied, "I think it is just my personality that I want to do well. . . . I am very persistent and I am hardworking. Curious about things. Like to know why."

Competition

Darren and Lisa cited a competitive spirit that contributed to their success. As previously mentioned, Lisa's competition was focused on not being beat by "it," meaning the situation, the difficult mathematics or anything else that sought to rob her of her self-concept as a good student. However, Darren took great delight in pitting himself against a very talented friend, who may have never engaged in the competition, but offered great inspiration, challenge and thrill to Darren. They were in all of the accelerated math classes together through the years and this made Darren very happy. He described the dynamic of this competition.

> We didn't say that we were trying to beat each other. I know I was trying to beat him. He was so smart. He wasn't studying, but I was. That really helped me.

Darren added that when the pace of the courses slowed down in high school because of the presence of those students who were older and less than the middle school "genius" kids, it helped him be successful through the end. He thought it "really made it easier and probably made me stay in it longer, the program." He vented, "It was ridiculous how fast they were in middle school. I thought they could slow it down just a little bit, even the smartest kids in there were having trouble. It was just too fast."

Robert wanted to be sure to name those "little AP prep and review booklets" as contributing to this success. He said, "You don't need to have trouble with the stuff that you're supposed to know and that's why I advocate those review books that give you the short itemizations of everything."

Perceived Benefits

All of the students thought the experience of participating in the accelerated mathematic program yielded positive benefits for them. Gregory was pleased with the way that it ultimately gave him options to take courses that he was interested in. He mused,

> Being able to take the math early like that allowed me to take more of the other stuff. For instance, I got to take AP music theory and I don't think I would have been able to if I hadn't taken the accelerated math. . . . And because I had taken Calculus in my junior year, it also opened up options for me to do a joint enrollment. It has actually opened up a very good opportunity for me in college. I am going to pursue a double degree at Peabody in Recording Arts and Science and Music Composition. If I hadn't had the math background that I had and the accelerated math that I did take I might not have even been accepted into the Recording Arts part of the program because they really looked at your math background. So I was really happy.

Lisa was pleased to have escaped boredom. She described making good grades in classes where she had not even attended the class.

> I am never bored. I guess that's positive. In elementary school, I was so bored. I got my first B in 4th grade in math because I was too lazy to check my work because I was so bored. I got my second B in 4th grade because I was skipping science class to go play violin with the middle school. Then I had to come back and take the test and have not had learned anything but I still got a B. I was really bored. So it's good not to be bored.

Darren was glad that he had the math courses that he needed to be accepted to the college and program that he dreamed of. Robert thought that a real benefit was the environment of learning, studying, and interacting with other students who were bright and who constantly challenged each other.

> I like the environment that the advanced classes provided; that group of kids that were taking accelerated math. . . . When you have the brighter students it clicks well and then it pushed you better as well. We kept pushing and pushing each other along. . . . The class only moves as fast as the slowest students. You don't want to be pulling everyone all the time.

Carla also valued the challenge of the courses. She said, "I liked the experience of challenging courses." Janine was also grateful for finally experiencing an appropriate challenge and she valued the lessons of life that it brought, including struggle and failure.

> Because of this program, I have been challenged in mathematics for the first time in my life. Also, I have been able to take math courses that I would not normally be able to take if I wasn't accelerated. We knew that it could be above your head. We knew we needed the challenge. We knew it would be better for us in the long run and I would say from being with all these students for all these years that 90% of us had a good experience. You heard a few here and there complain and drop out because it was not best for them. We all stuck together and it ended up being a positive thing for most of us. When I learned to take failure, too. I had always gotten As on my tests and I get in Algebra II and I am making a C on tests. I had never made a C before and then it was that initial shock and then you can get over it now. I know I'll be making Cs or Bs; you never know. You get a test back and it's not always going to be good, but I think that helps, too, to know that I'm not always going to be perfect. I'm not going to make a 112 on my tests forever.

Negatives Associated with Participation

Throughout the interviews the students talked about various difficulties during the experiences, but when queried specifically about whether there were any negatives associated with participating in this accelerated math program only three of them mentioned anything. Darren and Robert both thought there were times when the pace of the instruction in the class was too fast. In particular, Darren also thought that his experience learning Geometry was negative because of the pace, which had caused him to not remember any geometry principles. Robert recalled, "I knew there were some things that it seems like we went through so fast that I didn't really pick up. But that's the stuff you learn just to learn it, you memorize and don't understand how it applies because there is nothing to hang on to."

Janine reported that one of negatives was the high levels of stress that she experienced, although she admitted that because 12th-grade was such an easy year she

had somewhat forgotten how stressed she was in 10th and 11th-grades. She said, "There were times when I didn't enjoy math. It wasn't fun anymore. It happened to everybody here and there. It was almost too much. It almost takes a special student, someone who is very willing and has a good work ethic." Janine also reported her struggles to adjust to the demands of the many high-level classes that she had put herself in, but she said, "I've never regretted it."

Though the mention of the pacing and the stress were provided in response to the question about negative experiences, there were other issues raised in the interviews which I categorized as negative experiences. Again, when asked, the students did not raise these as negative issues themselves but they were so passionate about them during the interview that I include them here. The greatest issue was that of not having qualified teachers. For Janine this happened in her eighth grade Geometry class. Janine actually did not fault the teacher, claiming, "She just didn't know what she was getting into with us and she had just taken a course in how to teach it." Nonetheless, Janine felt misled, cheated, and deficient until her high school teacher remedied the deficiencies. For Carla, this occurred during her 10th-grade Analysis class. The teacher had to leave her teaching assignment because of an illness in her family. Carla didn't blame the teacher, but the parade of substitutes was exasperating. Carla said, "After a while, it was ridiculous." During the interview, Carla also strongly raised the issue about the order of the classes and thought that if the order of Calculus and Statistics had been reversed so that she could have taken Statistics first, she would have been much better off.

Students' Descriptions of Self

McLeod (1991) described two major categories of beliefs that have had an influence on mathematics learners. They are beliefs about mathematics and beliefs about self.

> The most recent assessment (Brown et al., 1988) indicates that students believe that mathematics is important, difficult, and based on rules. These beliefs about mathematics, although not emotional in themselves, certainly would tend to generate more intense reactions to mathematical tasks than beliefs that mathematics is unimportant, easy and based on logical reasoning. (McLeod, p. 63)

In keeping with this idea, many emotional words were used throughout the students' interviews in regards to the mathematics and the experiences. They included, "torture, cruel, hell, hated it, bearable, blew my mind, boot camp." There were a few positive emotional expressions used as well. They were "It was a blast, I was so happy I was freaking out, it 'flowed,' I was jumping up and down."

"Flow" is a term used by Mihaly Csikszentmihalyi (1993) to describe the experience of an optimal fulfillment or engagement. It is interesting that Robert chose that word to describe his feelings about mathematics. Darren referred to being so happy with mathematics that he as "freaking out". I imagine that the two would equate the terms as expressions of fulfillment and happiness with their status.

Regarding beliefs about self, McLeod (1991) reported that "research on self-concept, confidence and causal attributions related to mathematics tends to focus on beliefs about self" (p. 64). Most of the research in this area indicates that there are substantial differences between men and women on this dimension, with men being more confident. This was not apparent in the interviews I had with the women. Even though some of them admitted to crying in response to some challenges, the students pushed

through those emotions and took action, not indicating that they questioned themselves. Recall though that Gregory indicated that he wondered whether was on the right path when he made his first B in Geometry. He questioned himself, but also coped by working harder.

At the onset of the research I had planned a couple of broad, open-ended questions to open the interview sessions with. I hoped these broad questions would prompt the students to feel comfortable enough to share the nature of their experiences. I did not have any planned questions concerning what the students were like as people, as learners, and what motivated them. Because it was unplanned, I found myself fascinated by what the students revealed about themselves and what motivated them. This section examines their self-descriptions and the changes they thought they had made as they lived out this experience.

Gregory described himself as being a hard worker up to and during his 10th-grade year in school. When he struggled with Geometry proofs in the eighth grade, he said he

> just kind of worked through it. I think part of the challenge was figuring it out because I wanted to figure it out. But I still didn't like it. So I just had this drive. That's what kept me going. I didn't want to give up.

During his junior year in high school he described easing "off on myself" and how, when he gained some new perspective, he changed. He thought this change didn't mean that he didn't care at all, but that previously, making As was part of his identity. He said, "not to the point of there goes the nerd, but I think definitely you could say that was a major part of my identity." I found it interesting that he did not share the views that he thought the teachers had of the accelerated math students. "They viewed us in a higher way than we deserved. Just because we are taking a higher class doesn't mean that our intelligence is that much higher."

Darren described himself as someone who really enjoyed competition and someone who really enjoyed mathematics. He also believed that enjoying math set him apart from the rest of the students, as he did not believe that they cared as much as he did about learning math. He described being motivated early on by needing to prove himself worthy of the waivers that allowed him into the classes. When he no longer needed waivers to continue in the accelerated math classes, his motivation changed.

> I think by my freshman year I wasn't as motivated by achieving. I felt like I had already achieved what I had wanted to achieve. I guess it was to prove myself in middle school and my freshman year. By the end of the years, I think I was just trying to get more out of the classes. I was trying to get into engineering school, Marine engineering school, and I knew it would help me.

As Darren described himself, he was a goal setter from an early age and he doggedly held a focus on his goals throughout the years and throughout his difficulties. "Since 4th grade. My brother was in school and he was going to all these neat countries. They train the cadets on the ships and they go to European countries, Greece, so I really wanted to go to school because of that."

Robert described himself as a "pretty friendly guy and not afraid to meet new people" but a "loner when it comes to studying." In terms of his approach to getting through this challenging course of study, he thought he was just carrying out his expected role or job in life at that particular time in his development. He just accepted it. Robert simply saw going to school, taking it seriously, and maximizing the time spent there as what was expected of him and what he needed to do.

> I'm not really sure but I can take school with a grain of salt sometimes. I have to be here. I need it for my future. I just maximize the time I have. Get everything you can out of it. I thought that taking the advanced math courses would do that. And, mind you, I didn't push myself just for the grades because then I could have taken Multivariate Calculus this year. You've got to know your limits as well.

He also said, “I guess I was motivated to make the most of my time in high school and be as knowledgeable as I could. I guess that’s the purpose of all the schooling we go through.” He described changes that he saw in his views when he was asked to describe success.

> If you had asked two or three years ago, I would have told you that success is measured by how close to 100 your grade is. About a year ago, that was the case. I think it is understanding. There is nothing wrong with doing well. That’s an integral part of proving your knowledge.

As Carla described herself, the portrait emerged of someone who is extraordinarily determined and someone who highly values understanding of a concept and completion of tasks and expectations. When faced with extreme difficulty in her math learning experiences, her self-talk was filled with, “Well, I know I can do this. I would think about it and think about it and I would know that I can do this. I’d go back for extra help and figure it out and keep learning. I can do this.” Of her personality, she pronounced, “ Like I hate— I can’t not finish something for homework. Completed. I don’t like not doing something.”

Lisa frequently described herself with the word “determined” during her interview. She shared the lessons she had learned about herself as she struggled and met challenges. She in particular had, at various times throughout her interview, talked about how little mental exertion had been required of her before she took challenging math courses. Through this experience she had made some changes in her view of herself in her academic world. She mused about what she had learned about herself.

> I’m not invincible. I don’t know. Just that it’s easy when you’re younger. Like “I’m so smart. I can get As in classes and not do my homework” and then along the way you learn “Well, maybe I’ll have to work a little. That’s not so bad. I don’t have to study so much; I can study just a little.” And I got through class like that. And this [calculus class] was like no matter how much I study, no matter how much homework I do, I still

> don't get it. I'd eventually get it and I'd get upset about it. I don't get upset. It's not worth getting upset over. Math just isn't that important.

She reflected on her determination during the challenges, her options and her view of herself.

> I didn't have an option. I am kind of a determined person. At that point, you're halfway through a semester. Nothing you can do but keep making sure you don't fail. There is no other way to go. I guess I could have just failed, but my Dad wouldn't be very happy with that.

Again, on her determination and her self-concept, she said,

> I guess that I'm just determined. There are certain people who . . . I guess I have always been good at academics. I can be good at that and I didn't not want to be good at it. I didn't know what I'd be good at them. I had to be good at something and that was it. That was what I was going to do.

Of the many things said to me over the course of the interviews with the students, Lisa's statement above struck me as one of the most profound. It took me by surprise when I realized how much was at stake for her and therefore for some students. I was surprised to gain so much insight into her self-perception. I read it that she saw her only talent as being good in school and that was all she knew how to be good at. If she lost the perception of herself, she would be lost. Inexplicably, I found myself sad at this realization.

Levels and Sources of Challenge and Ease

All of the students reported some aspects of the mathematics and the associated learning experiences as easy or difficult. An undeniable pattern that emerged was that most of them reported serious mathematical and learning challenges during their study of the Analysis course. Darren was the only exception. Darren reported that he was so happy in Analysis with the extensive use and application of algebra that he was "freaking out." The rest of the students represent four different high schools and all reported difficulties with Analysis. Robert said that there were times in Analysis class when he "did it, but did

not understand." Janine reported Analysis as being the "hardest math class of high school" because it required deep understanding, "very, very in depth thinking," critical thinking, critical analysis, and the homework load was heavy. Carla said that she "hated it. I wish I hadn't taken that class. I wish I had taken that class in 11th-grade." She reported her difficulties with it as it did not seem logical, it was very fast, "way in-depth, more challenging, you've got to think a different way," and she failed two or three tests while taking the course. She claimed it was the first time she had ever needed to pay attention in class or ever needed to do homework. She described it as a scary, frustrating time that caused her some self-doubt. Lisa heard from friends that Analysis was "hard and impossible." A friend who she considered an intellectual peer was "not doing so well" and got a C in the course. Lisa struggled with the Analysis teacher's style, which she said "forced her to work," and she struggled with the learning. She resented having to figure out so much on her own.

Darren, who loved Analysis, reported extreme challenges during Algebra in the seventh grade. He said, "I have to say that Algebra is actually one of the most difficult classes that I have had in all the accelerated math. I was struggling like hell. I think I ended up with a B in that class. I don't know how." Janine and Carla were both utterly dismayed with their Geometry courses in the eighth grade. Robert's frustrations and difficulties surfaced when he studied Calculus and Physics in the same year and tried to make sense of one in terms of the other. Lisa experienced extreme difficulties trying to understand the mathematics of Calculus class.

In each case, the students somehow coped with some difficulties and found their way to success. They most often reported "working hard," working with another student,

forming a group within the classroom for self and group teaching without the teacher's input or influence, seeking support from parents, and crying as ways they used to cope with their difficulties.

Darren said he studied "so hard" in Algebra because he was there on a waiver and had fought so hard to be in the class. Mostly he felt overwhelmed but kept going, working hard, drawing on his love of math. He said that he studied more in math than in any other subject.

Lisa coped with her struggles in Analysis by keeping up with her homework, which was not her normal behavior, and trying to teach herself by reading the book. "I don't think I've ever read a math book in my entire life and they don't get easier or more fun to read, ever. I guess it was self-teaching almost. Then you could go in the next day and your greatest accomplishment was having only one question instead of eight. Self-dependence, I suppose." Lisa's struggles with Calculus were also great. In this class she coped by crying. During the spring semester of Calculus a friend of hers joined her in the bathroom crying spells.

> I had a friend who also did that occasionally. We were in the same class spring semester and I think she actually got a C in the class. She wasn't doing so well either. Occasionally we would have "We're going to leave the room now."

She said that she never generalized this frustration to the idea that she might fail the course. The frustration existed only while she was there in class. She elaborated,

> It was only like the moment. Leave the class and then I'd be okay again. It wasn't the concept that "Oh, I'm going to fail Calculus" because I had other things to be thinking about once I left the class. I left the class. It was over. It was just while I was sitting there and everyone else was going on and I didn't know what to do. I had to keep going to class and I had to keep trying not to fail. I did it. I don't know. [She laughed.]

Lisa coped well enough to have scored the top score, 5, on the AP Calculus AB and AP Calculus BC exams. She said, “It clicked like three weeks before the AP test which didn’t do me much good because by then I had like a D [in the course] but it happened.” She concluded, “I do well under pressure, I guess.”

Robert coped by taking the counsel of his father to heart. His father frequently counseled him that he was in math “boot camp.” There were just some things that you had to do, learn the basics, and move on. That is your job when you are a student. So Robert did, often not understanding what he was doing or learning, but trusting that somehow it would come together. He described his most difficult, and most exciting, learning experiences that occurred in 11th-grade when he took both Calculus and Physics. This was the time when it all finally came together, the time he had been waiting for. He said, “Putting physical motion on to a graph or mathematical terms. That was something totally new. That was the first time that I got excited about math.”

Carla, Janine and Gregory attended different middle schools but all described some of their greatest difficulties occurring with their eighth grade Geometry classes. Gregory made his first B ever in the first semester of Geometry but let it serve as a wake-up call. He coped with difficulty by working hard. He said, “The first portion of that I got a B, I think actually my only B in middle school. So it kind of startled me a little; got me thinking about should I really be doing this. . . . So I worked a lot harder and studied more. I ended up doing fine the rest of the time.”

Janine attributed these difficulties to poor teacher quality. Janine felt that she suffered in her subsequent courses from a lack of background in geometry basics and

"hated it at the time." She coped by taking the issue to the Principal of the school and helped form peer learning groups in the classroom. She shared,

> we got into different groups and helped each other learn it and we felt like we were teaching ourselves almost, which is unfortunate. I think we all ended up doing pretty well but it was just a very frustrating year. Had to have a lot of peer help and we all thought we were teaching ourselves geometry.

Janine said that this type of coping had occurred later in some high school math classes as well, when a teacher left in the middle of the year and there were numerous substitutes. I concluded that this situation Janine had heard of was the same one that Carla reported as part of her experience. Janine's impression was that "I think the year was as frustrating for them as it was in eighth grade because they suffered the same thing. They weren't getting taught. They were teaching themselves because they had substitute teachers all the time."

Carla had difficulties with Geometry, first semester of Algebra II, and Analysis. Carla attributed her geometry difficulties to the fact that she was "more of an algebra person." She faulted the teacher for not including more proofs in the geometry experience and also thought her teacher did not handle questions very well. Carla coped with the situation by "do[ing] it anyway." She made a grade of 95% in the class but said it was hard and she did not like it. "I just didn't enjoy doing it. I just get frustrated. I don't want to do it, but I do it anyway. Then I get mad." She eventually gained understanding of her lacking geometry concepts in a subsequent year when she helped her younger brother with his Geometry course. Carla also had difficulties in her Algebra II class associated with the teacher who left in the middle of the year and the class had numerous substitute teachers. In this case she "just taught myself. A lot of people didn't. But the stuff we were doing in first semester was easy." Carla's difficulties continued with her Analysis course

and she failed the first two or three tests. She described her difficulties with the different kind of thinking that the teacher demanded, the fast pace of the course, and the way the teacher made them apply their learning to new situations on the tests. She coped by crying and adapting to the teacher's style. She took advantage of every extra-help session and every make-up and review opportunity that she could earn credit for. She said,

> I thought I was so good at math. I hit that classroom and I said, "Like, whoa, wait, I had to pay attention." Before that I didn't have to pay attention. I did my homework just because it was my homework, but I didn't have to if I didn't want to. I still would have gotten okay. But that was the first class I actually had to do the homework and I had to understand what I was talking about. Kind of scared me at first. Maybe I'm not so good in math. But it just kind of frustrated me.

As seen previously in Table 10, Carla said she had a grade of 83% at the time she filled out the survey in 10th-grade. In her interview, she recalled that she had an 83 and knew what she needed to make on the final exam in order to make an A in the course. She set out to make that grade on the final and she did indeed pull out an A, 90%, for her course grade.

Peers

The students interviewed volunteered information about their experiences with some of their peers during their school experiences. As well, a couple of them shared stories about their peers' experiences. This was definitely a welcome development. I was particularly happy that this happened because I was concerned that I would not be able to know about some of the students for whom this was not a good experience. I reasoned that anyone who had not had a good experience with the acceleration program might be quite unlikely to respond to the voluntary survey, share information, or want to be interviewed. These stories fall into two categories: the interviewed students' interactions and relationships with their peers and the second-hand stories of their peers' experiences.

Lisa relied on the support of friends and peers. After she related that she cried frequently in Calculus class, I asked if her parents knew and what they had to say about it. She shared that her mother had died when she was little and that her relationship with her father was not very "parentish." When I asked her about what might have happened if she had never experienced any of her struggles before she went off to college and experienced them there where she would not have had close parental support, she agreed that it might have been difficult if it occurred before she made new friends.

> So the only hard part about that would be if it happened like fall semester and I hadn't made any good friends and because really my friends get me through everything, including stress with calculus. They are like my family. I'm close with their family. That's how I am. So I guess it would have been harder if I'd been somewhere and hadn't made good friends yet. If it were spring semester and I'd met a few friends, it would probably have been okay. It would have stunk still, but I would have gotten through it.

Some of the friends that she made in the small sixth grade accelerated class she was still friends with. "The 13 of us got along really well and I'm still friends with some of them because I guess being put in a class for two years with 14 people, you've know them forever that way." It intimidated her when her friend, an intellectual peer, was struggling in Analysis and her frustration was high in Calculus when in class with "lots of very bright kids in there and they got it just like everything else." She spoke of the attitudes of peers and tone of her Statistics class when they were all seniors.

> We had a lot of people drop out because it was 4th period. A lot of seniors taking minimum day switched into another period and dropped something else. A couple of kids dropped the class altogether. Going to take an easy senior year, spring semester, last period. I think we had 11 kids total.

Lisa spoke of a friend who dropped out of Calculus after the first semester. "I didn't let the difficulties burn me out, I guess. I had a friend who dropped out after Calculus AB and she didn't take any more math. She didn't take a senior year math; she

was done. She has five credits of math. I have seven credits of math, which is ridiculous." After she mentioned her friend, I asked if she knew of any other people like that. She replied,

> A few here and there. Probably four or five, out of a group of 30 from [school name] and [other school name] combined. Some people who just happen to be good, bright in general, and math was something they really enjoyed. They did it because they weren't being challenged. And then they got to the challenging point and it was like "I don't really care about math so why stress over it. I don't care if I get these credits." . . . So people who aren't doing anything math related, didn't have a passion for it, but were just bright. So I figure that was success that I didn't reach that point.

I wondered if she knew of any peers that stopped taking math after the required four courses needed for graduation, which on this path could have been accomplished by the end of 10th-grade. Lisa replied, "I don't know of anyone who stopped after four."

Darren's most pronounced experience with peers was centered on the competition that he placed himself in with his very bright and much admired friend. He loved the competition. He worried about them for the future. "We are still really good friends. He's moving away to New Orleans, a college in New Orleans. I'm not sure how we're going to keep in touch. No more competition." As he moved to high school math courses, he was very grateful for the presence of older students in his classes. Regarding his ninth grade Honors Algebra II class, he said,

> I have to say, it is actually easier. We had other students in there from higher grades, probably 11th-grade, that were in my class. They actually taught us slower. . . . They helped me a lot. I'm glad they slowed it down a little bit. It really made it easier and probably made me stay in it longer; the program.

Darren thought the younger and older students blended nicely together because it was still an Honors-level class and "the kids that were in it were still mature, I guess." This was a welcome change from the middle school experience where all of the students

were young, bright, and on the same very fast path. This pace returned in AP Calculus AB and BC. Of that class, Darren said, “I think that only some of the smartest kids were in the class. So it was very high speed and pretty difficult.”

When Janine had the difficulties with the eighth grade Geometry teacher, she and five other girls went to talk with the Principal about the situation. It was with these five girls that she formed the peer teaching groups in the classroom and they helped each other through the course. She said, “we got into different groups and helped each other learn it and we felt like we were teaching ourselves almost, which is unfortunate. I think we all ended up doing pretty well.” She reported that they all made it through that year but “when it came to ninth grade, and we started in our advanced ninth grade classes, a few people dropped out in the middle of the year because they didn’t think they were prepared enough and have the basics.” She said that this was only a two or three students out of her middle school class of about 20 students. Janine liked being in math classes with all students who were the same age and in the ninth grade. Later in 10th-grade, she felt that she was ready and looking forward to meeting new people. She shared,

> There are always people in your class that you wish weren’t in your class and then if you are stuck with the same 20 people over and over then you are not likely to go out and meet new people.

She enjoyed the challenges of being in classes with students who were “definitely very bright in mathematics.” She clearly admired their talent and thinking. “I’m not one of these people who went into the math class and knew all the material and there were kids like that. They brought up things that I would never in my life think of. It was another way of challenging myself I guess.” She thought the presence of those peers forced her to work harder.

Janine shared that many of her peers were unhappy about not receiving an Honors level quality point for the advanced work they had completed in middle school. When these same courses were taken in high school, students were awarded extra points on their grade to reward the rigor and the pace of the Honors courses. The competition for highest GPA to determine valedictorian was fierce, and she said that many people were anxious and nervous about that. The last thing Janine and I talked about was how difficult it was to know who something like this is right for and who it is not right for. She shared this comment about some peers.

> I had friends like that who did make it into the program initially in the sixth grade and their parents got them into it in the seventh grade and they did real well. But then there were other students who initially got into it and had a hard time. It is hard to judge. Especially in sixth grade because you've never really had math like that before.

Reflecting on the overall experience for herself and her peers, Janine mused,

> We knew it could be above your head. We knew we needed the challenge. We knew it would be better for us in the long run and I would say from being with all these students for all these years that 90% of us had a good experience. You heard a few here and there complain and drop out because it was not best for them. We all stuck together and it ended up being a positive thing for most of us.

Regarding peers, Carla shared that she liked being grouped with "people who understood math more" in her early middle school experiences on the accelerated track. She shared that in the ninth grade when the Algebra II teacher left in the middle of the course, some of her peers did not cope the same way she did, which was to teach herself. They did not understand and gave up. When asked what she thought happened to those students, Carla said, "I think they got like 70s and 60s. I know a girl that got a 70 and it messed up her whole GPA. It throws off everything else because you don't want to go higher because you don't think you know what you are doing." This particular friend

continued taking advanced math courses but not on the accelerated track that Carla remained on and Carla thought her friend was "okay" with that.

Like Janine, Robert thought that the experience was generally a good one for most of his peers and overall felt that "I don't think you can start too early on Algebra and all that stuff. I think it is a good idea." With that said, he shared the experience of a good friend for whom this path was not the right thing.

> I had a good friend. He's one of my best friends. We've been through school together since elementary school and middle school. We were in the same math class but he ended up he took the first quarter Algebra I in seventh grade and then just got out of it. Too much for him. Probably the right thing then, too. If the shoe doesn't fit, . . . Well for him, I think it was the right way to go. I think for a lot of people and what they have achieved academically is a direct result of how motivated they've been and how much effort they put into it. For him, his priorities in his family, his priorities are not as focused academically as maybe my family or someone else's. So I think that was [the case]. Pure intellect-wise, he was more than qualified. But I think he decided he didn't value that.

Robert was pleased that he had convinced this friend to take AP Calculus AB while Robert took AP Calculus BC. He said, "On a positive note, my friend, who I was speaking of, I convinced him last year to take Calculus instead of Statistics just because I thought that might be more valuable for him to get some exposure to that." He said that his friend had been afraid of the workload but took it. "I think that sometimes if you have exposure to something and even if you don't get it really the first time and then the second time it comes around, like when it hits him in college, he'll be a lot more well suited. It is not going to hurt as much when he does it."

Robert used the status of his peers in his classes to judge his own status. He reasoned that if everyone was struggling, it was probably okay that he was struggling. If others were doing fine and he was struggling, he knew he needed to worry. He thought that the group of students who had been in these classes for many years together formed a

bond because they had experienced the same challenges and the same frustrations. He thought that academics was always competitive and did not rule out that these students were competitive, but he did think that it was a good environment and that they learned by teaching and coaching each other.

As he went to high school he did not feel uncomfortable being in classes with older students and he felt complimented when asked for help.

> Coming in as a ninth grader, you're pretty green. If anything it motivated me to do well because the other kids are not going to look up to you for seniority, obviously. A lot of time some of the friends that I made in there were coming, saying "Can you give me a hand with this?" or "What's this and this and this?" To me, it's a pat on the back. I think it's complimentary when one student asks for advice or help.

One of the first topics that Gregory mentioned in his interview related to his peers. He thought that in the very first accelerated class, Algebra I, many of the students in the class did not belong there. He shared that as this group of students moved to eighth grade Geometry, some of the students did not like the teacher because "she did teach well and that means it is going to get hard sometimes." This was the class where he made his first B and others were making C's and D's. He thought this was due to the fact that they were not working as hard as they should or that they should not have been in the class.

Gregory said that he spoke for the whole group when he talked about the Honors credit issue. "One thing that we didn't like, kind of as a whole, as a class of people taking it, was that we didn't get the Honors credits and we felt, especially in Geometry, that the rigor of the course was worthy of it. But we didn't get it because it didn't work that way. So we were kind of upset about that."

Regarding being a younger student in a ninth grade Algebra II class, he said he thought it was funny that the older students joked about him being "smart young guy."

When pressed about how he felt about it, he said it was "something to laugh about," but he was ambivalent about whether he enjoyed going to class or what he remembered learning in the class. He said, "I don't think I looked forward to it. But I didn't not look forward to it."

Gregory's sister was a year older than he and was taking the same courses he was taking. She was on the advanced track; he was on the accelerated advanced track. He said, "Something else I heard from my sister, that seventh grade math wasn't learning new stuff, it was just doing old math. They thought it was pretty much a waste. They were kind of jealous that we got to do what they were doing and what they felt like they should have gotten to do a year early."

I explained to him that it was very tough to know when and to whom to offer this program of study and my concern about possible negative ramifications for students experiencing it. He replied, "No, I think that problem solved itself in high school. Especially after Geometry. Some people decided to go into Honors Algebra, some decided to take Geometry. It works itself out." He said he thought that they were all okay and continued, "Geometry is probably a struggle for some of them, but once they are out of that they had the freedom to decide. That allowed the problem of people not belonging there to work itself out." His advice to students trying to decide whether to choose this path of study was

> I would ask them what have you taken in sixth grade and I would hope they would say Pre-Algebra. I would ask them what their grade was and hopefully it would be a good A. I would ask them how they felt about the material, if they understood it. I would say, "Go for it" definitely. I would ask them if they were willing to work a little bit harder than they did before.

It is interesting that these students had so much admiration for their peers in their mathematics classes. Generally they declared their peers to be much more capable and smarter than they. They frequently described with amazement and admiration what their peers were thinking and the ways they were thinking. They often described how much they liked this exciting environment for learning.

> Growing evidence supports the value of peer stimulation of gifted students with one another. In a review of mathematically gifted students, Sowell (1993) found that "Precocious students enjoy working alongside others who are precocious; the fast pace appears to be invigorating….Situations in which students spend greater amounts of time together appear to be conducive to greater achievement and more positive attitudes than situations in which time with peers is limited" (p. 128). (in Colangelo & Davis, 1997, pp. 17-18).

CHAPTER 5

CONCLUSIONS

Limitations

The length and span of time involved in this research might be noted as a limitation. This study involved interviewing a sample of students who were among the original participants in a curriculum of accelerated and advanced mathematics during a six year period. Some researchers might not expect to devote the amount of time that I have to this project.

The timeframe during which the students studied in the accelerated mathematics program was six years from grades 7 through 12. The timeline for a variety of research efforts regarding their experience spanned six years as well, but it occurred in different segments, with different purposes and intentions. For example, in the course of my job as mathematics coordinator, at the end of the students' first year in the program (seventh grade Algebra I), I analyzed the end-of-course exam results of these students. I compared their exam average scores to those of students in eighth grade Algebra I and those in ninth grade Algebra I. They outscored both of those groups. Also, in the course of my job, in a subsequent year, I analyzed the surveys that the seventh grade Algebra I teachers had completed at the end of these students' first year. At that time I was looking for changes in teacher attitudes or practices as a result of having taught these students. Obviously I needed to apply some research techniques to evaluate the program in the

course of doing my job. However, for purposes of formal research to complete a dissertation, the research reported in this document spans a timeline of three years.

Acceleration is often used to solve problems around students' dissatisfaction or unhappiness with school experiences. In this case, the pool of students from which the participants in the study came had not declared themselves dissatisfied or unhappy. This action came from the collective observations of their classroom teachers.

As well, this situation did not involve an isolated or individual case of a student being moved to a higher level course or classroom all alone. These students had peers who experienced this program with them. There was always someone else in their classes that was their same age. So this is not a typical case of individual acceleration as one might find in the literature.

Last, though every attempt was made to include students of diverse backgrounds, all of these students were white. While I do not know the socioeconomic status of each of the students interviewed, none were from the southern region of the district that is characterized as being heavily populated by families of generally low socioeconomic status.

Conclusions

In my opinion, the results of this exploratory study should trigger additional questions that will encourage research that can determine, define, or illuminate the social construction of a mathematics acceleration experience, whether acceleration is a socially constructed notion and/or whether ideas about what is developmentally appropriate are also socially constructed. It is clear that the students in this study suffered from a lack of appropriately challenging learning experiences prior to this accelerated program of study.

TIMSS and other international tests clearly indicate that even our best and brightest students are not reaching the same levels of achievement that students in other countries are or the presumed high levels that they could and should be reaching. For example, 44% of Singapore's students reached the TIMSS "advanced international benchmark" when only 7% of U.S. students did. "And, in general, the longer students had remained in the U.S. school system, the worse they performed relative to their peers abroad." (The Editors of *The New Atlantis*, 2005, p. 112).

I believe that educators must question whether what we call acceleration and advancement in the United States is either. These students had struggles, but those may have come from adjusting to the demands of an appropriate challenge in school. Many of the participants interviewed said that they had never studied before this, in anything, at least during the years of Kindergarten through sixth grade. It is a challenge when the norms under which a person has been operating in a system suddenly change. What these students were doing in seventh grade and eighth grade accelerated classes is routine and normal in other countries, such as Germany, Japan and Singapore. So is the prevailing notion or definition of acceleration in the United States socially determined?

For me, this raises the issues and questions that were discussed in the opening of this paper. Advocates for gifted and talented students believe in the benefits and appropriateness of the U.S. version of acceleration. They are right to do so. Oakes (1985) insisted that teachers who teach lower-level students have lower expectations. She is also right. When we consider Vygotsky's (1978) work on the zone of proximal development, we see that the appropriateness of a task or challenge is key to successful teaching and learning. A student who is bored does not learn and a student who is overly stressed with

anxiety from too complex a task does not learn. Both sides are actually arguing for appropriate challenges to further student learning, development, and achievement. All of these students reported benefits from this challenge, mostly described as being able to have opportunities to realize their goals and dreams. Students who are not offered the opportunities for appropriate challenges cannot derive similar benefits.

More insight comes from the struggle that the majority of the participants experienced in their Analysis classes. You may recall that this was the first time they put it all together and the first time they had ever been asked to think in a "different" way. A possible reason for this struggle is that teaching of mathematics topics in the United States is characterized by being very compartmentalized. That is, strands of mathematics are frequently taught in isolation and by the time a student reaches high school or higher mathematics classes, those strands become courses. Those courses include Algebra, Geometry, and Statistics. Analysis is the course that brings and weaves together the concepts of Algebra and Geometry for the first time. So in teaching the strands discretely through the years in school, it does become an entirely new experience to use algebra and geometry concepts together. Thus, great difficulties can result in adjusting to this new approach. Some districts and states that have adopted an integrated approach to teaching mathematics topics and strands may do better with this. This would also be an interesting topic to research.

We see in each of these cases, that parental support without extreme pressure also was very important to these students' motivation and success. As well, we see that the teacher matters very much. This is neither new nor surprising. The majority of the students reported that their teachers were a factor in the students' success, but even when

the students reported issues and difficulties with their teachers, those events were neither trivial nor forgotten.

I believe that there is a degree of transferability from this study to a larger and more pressing dilemma facing educators in the United States at this time. Under No Child Left Behind legislation, educators and policy makers are faced with the challenges of educating all children, in all demographic subgroups, to higher levels of achievement. It is both a legal and moral mandate. It has features of the same set of circumstances that the students in this study experienced, that is, no matter what a grade a student is currently in, somewhere on the continuum of a K−12 education, the standards and expectations are being raised. The standards and expectations for the students in the study were raised when they were in the seventh grade. The standards and expectations for all students, in all grades K−12, are now being raised throughout the United States. The experiences of the participants in this study give us a window into what this experience was like and therefore what it *might* be like for other groups of students. Though these are the descriptions and reports of very capable, very determined, and very focused students, we should expect that ALL students adjusting to the demands of higher standards and expectations in the middle of the stream of their K−12 education might have some difficulties, challenges, joys and benefits as they progress and adapt. Perhaps further research into the experiences of other groups of students, such as those No Child Left Behind subgroups and groups of students who are less determined, focused, and motivated, will be triggered by this report.

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APPENDIXES

APPENDIX A

Survey

Letter to high school counselors/Learner Support Specialists to accompany the surveys:

---------County School District
School Improvement Division

To: High School Counselors/LSS

From: ----------, K-8 Mathematics Supervisor

RE: Survey of Hyper-accelerated mathematics students

Date: May 11, 2001

Dear LSS;

This is the fourth year that ---- County has had a "hyper-accelerated" mathematics curriculum in place system-wide. Students in this program completed Algebra and Geometry in middle school, opening the door to more and higher mathematics courses than many students have the opportunity to experience in high school.

Many of these students are meeting the state requirement this year for 4 math credits and could "opt out" of mathematics for their remaining high school years. To better gauge the student's perspective on this program, we are conducting a survey.

Because many of these sophomores are not currently in a math classroom, we are asking your help in delivering these surveys directly to the students. It was suggested by the ---- County research department that you (counselor/LSS) would probably be the best way for us to get the surveys into the hands of the appropriate students. We appreciate your help with the important project.

Enclosed are the surveys with an introductory letter and a return envelope (students will return the survey through the county interschool mail). All surveys are labeled with the student's name. Once the surveys are in the hands of the students, it is up to them whether they choose to complete and return the information. We appreciate your time and you are contributing to our effort to determine what changes may be needed to make this program the best it can possibly be.

If you have questions or concerns, please contact me by email or phone.

Sincerely,

SURVEY

1. Please list the mathematics courses and the grades that you made in them during the following years:

seventh grade: Algebra I **Grade in course: _____**
Did you opt for Carnegie Unit credit? Yes No

eighth grade: Geometry **Grade in course: _____**
Did you opt for Carnegie Unit credit? Yes No

ninth grade: _____ Honors Level: Yes No **Grade: _____**

10th-grade: _____ Honors Level: Yes No **Grade: _____**

2.On a scale of 1 -4, with 4 representing an outstanding, exemplary, positive experience and 1 representing a very negative, distasteful, upsetting experience, how would your rate your experience in this program during the last four (4) years?

seventh grade: **1** **2** **3** **4**
negative positive

Comments: _____

eighth grade: **1** **2** **3** **4**
negative positive

Comments:_____

ninth grade: **1** **2** **3** **4**
negative positive

Comments: _____

10th-grade: **1** **2** **3** **4**
negative positive

Comments: _____

3. Have there been positive benefits to you by accelerating your study of mathematics? If so, what?

4.Have there been negative effects for you during your study of math during the past four (4) years? Please describe them.

5. How strongly do you rate your Algebra background? That is, did your Algebra preparation provide you the necessary skills and knowledge and to the degree or extent that you have needed?

1	**2**	**3**	**4**
very weak			very strong

Comments: _____

6. How strongly do you rate your Geometry background? That is, did your Geometry preparation provide you the necessary skills and knowledge and to the degree or extent that you have needed?

1	**2**	**3**	**4**
very weak			very strong

Comments: _____

7. How would you rate your enthusiasm and enjoyment of mathematics at this time?

1	**2**	**3**	**4**
extremely dislike			extremely enthusiastic

Comments: _____

8. What are your plans for your math course-taking for your junior and senior years in high school?

9. What are your plans following high school graduation?

10. What suggestions for improvement can you offer regarding this program?

11. **Would you be willing to be contacted for an interview?** Yes No

If yes, please provide the following:

Name _____

Address _____

_____

Phone _____

Parent signature indicating permission for future personal contact regarding your mathematics learning experience.

Print Name _____

Signature _____

Date _____

APPENDIX B

Preliminary Telephone Interview Protocol

Date:

Student Name:

Contact Info:

1. Hello, my name is Dottie Whitlow and I was the Middle School Mathematics Coordinator in ----- County when you were in Middle School. You were given a survey when you were in 10th-grade that asked you questions about being in [an] accelerated math program. On that survey, you and your parents indicated that it would be okay for you to be contacted to talk about your mathematics experience over the years. Are you still willing to discuss your mathematics experience and is this a good time to do so?

YES NO ANOTHER TIME? _____

2. Thank you. I am now a doctoral student at Georgia State University. I am conducting research on what it was like for students like you to be part of an accelerated mathematics program for promising and talented math students. I'd like to ask you some questions about your experience in math class over the years. You will not be identified by name in the study and at any time that you do not wish to answer a question you may decline to answer. May I ask you some questions about your math experience now?

YES NO

3. I will be taking notes about your answers. In order that I capture your answers accurately, would you mind if I put you on speaker-phone and record your answers as well?

YES NO

Turn on recorder if okay.

If yes, please state your name and say that it is okay to record our conversation.

4. What school do you currently attend?

5. Are you taking mathematics this semester? YES NO

6.What class are you taking or did you take this semester or this school year?

7.Have you taken a math course each year in high school? What did you take?

9th _____ 10th _____ 11th _____ 12th _____

8.Do you recall the grades you have made in math over the past years? Do you mind telling me what your grades were? What were/are they?

7th _____ 8th _____ 9th _____ 10th _____

11th _____ 12th _____

9. Are you happy or satisfied with the experience of participating in accelerated mathematics over the past 6 years? YES NO

10.What do you think most significantly affected your sense of satisfaction/dissatisfaction with this accelerated course of study?

11. What was the most memorable experience (positive or negative) that you had or that you associate with taking this level of math classes throughout these years?

12.I mentioned earlier that I am conducting a research study on what this experience was like for students like you. If you agree that you'd like to participate I would like to interview you in person about your experiences in middle and high school math classes. Are you interested in being interviewed?

YES NO

13. Do you think your parents will agree to allow you to participate in an interview?

YES NO

(Or, do you need time to talk with them about this? YES NO)

14. IF YES to #12 and #13, establish a time, date and location to meet.

Directions:

15. If YES to #12 and #13, explain that written consent to participate will be need at the first meeting or can be faxed to both student and parent ahead of time.

Fax number:

16. IF NO, "That's quite alright. Thank you so much for talking with me today. May I contact you again if I have other questions? "

YES NO If YES, best time/day _____

APPENDIX C

Consent Form

My signature below indicates that I have read the information provided and I am choosing to participate in the study titled "A Mathematics Program Acceleration Experience for Mathematically Promising Students."

This research will be conducted after school hours, during mutually agreed upon and scheduled interview dates, times and locations beginning in April 2003.

I understand the purpose of the research project will be to understand and document the experience of students (such as myself) who participated in an accelerated mathematics program during six years, beginning in 1997 and ending in 2003. Such information would be valuable to policy makers and curriculum planners who make decisions about students' advanced learning opportunities in mathematics.

I understand that I will participate in the following manner:

1. Schedule a mutually agreed upon interview time, date and location with the researcher.
2. During the unstructured (i.e., no predetermined set of questions) interview process, I will be asked to respond to a few main questions regarding my mathematics learning experience as I recall it from seventh through the twelfth grade. I understand that additional questions will be raised during the interview to help fully explore the experience and help the researcher understand what I am trying to express. The interview is expected to last 60 to 90 minutes, but may vary if I need more time to tell about my experiences.
3. The interview will be audio taped and kept secure by the researcher until the final research report is made. When the research report is complete, the audiotapes will be destroyed.
4. Some time after the interview, I will be asked to review the comments that I made during the interview and tell the researcher whether my comments were understood or whether I wish to make changes or clarify some of the things that I said. This cycle could continue until I am satisfied that the researcher has accurately described my experience.

Benefits

The study may benefit the student who values making a contribution to the body of knowledge and research surrounding the acceleration of mathematically promising students.

There will be no other direct benefit to the student, but this study may lead to a better understanding of the experience of the mathematically promising adolescent and teen in an accelerated learning program, including understanding the benefits and drawbacks for the students involved.

I agree to the following conditions with the understanding that I can withdraw from the study at any time.

- The identity of the participants will be protected. There is only one researcher. This researcher will be the only person conducting the confidential interview and subsequently transcribing the audiotapes. Students will be assigned pseudonyms for any quotes or reference in the published research report and in any presentations.
- Information gathered during the course of the project will become part of the data analysis and may contribute to published research reports and presentations.
- There are no foreseeable inconveniences or risks involved to any student participating in the study.
- Participation in the study is voluntary and will not affect grades or anything else associated with school or academic experience.
- I can refuse to be in this study. I can stop being in the study at any time. No one can make or force me to be in this study or force me to continue in the study.
- If I decide to withdraw from the study after the study begins, I will notify the researcher of this decision.

If further information about this project is needed, I may contact

- The researcher, Ms. Dottie Whitlow, at 770-313-2735, 3181 Holly Mill Run, Marietta, GA 30062, or
- Dr. Christine Thomas (Ms. Whitlow's advisor at Georgia State University) at 404-651-0200, College of Education, Department of Middle, Secondary and Instruction Technology (MSIT)

The Georgia State University Research Office (404-651-4350) can provide me with general information about the rights of human subjects in research.

I have read and understand what is written above, and I agree to participate in this study.

Signature _____

Student Date Age

APPENDIX D

Coding System

Courses:
- Algebra I
- Geometry
- Algebra II – honors, synergy
- Analysis
- Calculus
- Statistics

Descriptions of Self:
- Work Ethic
- Beliefs
- Attitudes
- Motivation
- Relationships with peers

Success Defined:
- Happiness
- Accomplishment
- Learning

Success Attributed to:
- Work ethic
- Determination
- Self-concept
- Parents
- Teachers

Levels of Challenge:
- Difficulty
  - Mathematical
  - Schedules
  - Pace
- Ease
- Coping with Difficulties

Peers
- Relationships with
- Experiences

Benefits
- Achieve goals
- Admission to college
- Time to pursue interests
- Confidence
- Relief from boredom
- Gained momentum
- First time ever challenged

Negatives
- Teachers
- Schedules
- Pacing