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Looking at High School Mathematics Education From the Inside Out

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Abstract

United States schools are not providing students with the mathematical background necessary to compete on an international level and become successful adults. Recently, educators and researchers have focused on learning what factors might attribute to this lack of mathematical knowledge. However, few studies have searched for answers from the students themselves. The purpose of this study was to gain an understanding of how recent high school graduates, enrolled in college developmental mathematics courses, perceived the mathematics education they received from their K-12 institution.

Keywords

developmental mathematics, high school, college, K-16, school leadership

Mathematics has long been regarded as one of the most important disciplines in education and has been a part of our society since the beginning of time. The National Academy of Sciences (1989) discussed the importance of a strong mathematics background when they stated:

> Mathematics reveals hidden patterns that help us understand the world around us. Now much more than arithmetic and geometry, mathematics today is a diverse discipline that deals with data, measurements, and observations from science; with inference, deduction, and proof; and with mathematical models of natural phenomena, of human behavior, and of social systems. (p. 31)

Current high school graduates must hold skills in critical thinking, problem solving, and analysis in order to succeed in the most modest of ways. "The shift from an industrial economy to one based on service, information, and technology has dramatically increased the importance of advanced skills and credentials" (Wimberly & Noeth, 2005, p. 1).

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While, historically, the U.S. system of education has served many Americans well, it is clear that students must learn more and progress further in their education if the changing needs of our modern society are to be met (Tael & Eberhart, 1999). Today's graduates need the skills to function in a dynamic and digital society, and schools should adapt to the new needs of society and provide an educational environment that allows students to acquire those necessary skills.

Despite the rapid advances in technology and industry over the past 10 years, our nation's students have remained academically "stagnant," especially in mathematics. "The Program for International Student Assessment (PISA) is a system of international assessments that measures 15-year olds' capabilities in reading literacy, mathematics literacy, and science literacy every 3 years" (Lemke et al., 2002, p. 1). Out of the 39 countries analyzed in the PISA study, United States ranked 26th in problem solving and 24th in math literacy (Lemke et al., 2002).

The Trends in International Mathematics and Science Study (TIMSS; Gonzales et al., 2004) was published in 2004.

> In 2003, some 46 countries participated in TIMSS, at either the fourth- or eighth-grade level, or both. This summary highlights initial findings on the performance of U.S. fourth- and eighth-grade students relative to their peers in other countries on the TIMSS assessment. (Gonzales et al., 2004, p. 1)

This study used a different grouping of countries from the PISA study, but the results were similar. TIMMS found that "Belgium-Flemish U.S. eighth-graders were outperformed by students in nine countries: five Asian countries (Chinese Taipei, Hong Kong SAR, Japan, Korea, and Singapore) and four European countries (Belgium-Flemish, Estonia, Hungary, and the Netherlands)" (Gonzales et al., 2004, p. 5).

The findings of ACT have been similar to the findings in PISA and TIMSS. According to ACT (2005), 28% of freshmen entering postsecondary institutions enrolled in one or more remedial courses in reading, writing, or mathematics. ACT also said that "improving college readiness is crucial to the development of a diverse and talented labor force that is able to maintain and increase U.S. economic competitiveness throughout the world" (ACT, 2004a, p. iii). When students were not academically prepared for postsecondary education and therefore required remedial assistance prior to enrolling in regular postsecondary-level courses, they were less likely to complete degree programs (Adelman, 2004). Within 8 years of postsecondary enrollment, 58% of students who took two or more remedial math courses did not continue to obtain a college degree (ACT, 2005).

"As many as 4 in 10 high-school graduates are not ready for the demands that they face after graduation, whether they are going to college or to work" (Diament, 2005, ¶ 1). "The National Assessment of Educational Progress (NAEP)—known as the 'Nation's Report Card'—measures student proficiency in mathematics and science" (Research and Policy Committee of the Committee for Economic Development [RPCCEC], 2003, p. 10).

> The most recent administration of main NAEP, in 2000, found that 74% of fourth graders, 72% of eighth graders, and 83% of twelfth graders scored at

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> "basic" (the minimum standard of achievement) or "below basic" in math. In science, 71% of fourth graders, 68% of eighth graders and 81% of twelfth graders scored "basic" or "below basic." (RPCCEC, 2003, p. 12)

While researchers and educational leaders have, in recent years, given attention to the restructuring and reforming of public schools, providing a higher quality of education for all students, and increasing student achievement, many graduates still lacked the necessary skills to successfully transition from secondary to postsecondary education. The results of students graduating from high school without the necessary skills for college credit-bearing courses and therefore requiring remedial education are troubling. Patty Barth (2003, p. 31) found that "one in four freshmen in four-year colleges fail to return for a sophomore year" and that "in two-year colleges, the fall off rate is nearly one in two."

"For a healthy, prosperous, democratic society, all youth should be able to take advantage of educational opportunities beyond high school" (ACT, 2004b, p. 1). According to ACT (2004b), "nearly 75% of U.S. high school graduates enroll in college within two years of graduation, yet fewer than 56% of the spring 2004 high school graduates who took the ACT Assessment® took a core college-preparatory curriculum in high school" (p. v). The ACT study found that students who took rigorous, college-oriented courses taught by qualified, flexible, personable, and supportive teachers graduated high school more prepared for college than other students (ACT, 2004b).

The results of an inadequate education are numerous. As mentioned above, today's U.S. students are falling behind other nations academically and are leaving high school requiring remediation for college and work. As our nation continues to change in the 21st century, the need for college preparation, and ultimately a college degree, is increasing. "College graduates earn nearly twice as much as those with high school only; they are more likely to be and remain employed; and they are better able to adapt to the ever-changing workplace" (U.S. Department of Labor, 2003, as cited in ACT, 2004b, p. 1).

Purpose of Investigation and Sample Used

U.S. schools are not providing students with the mathematical background necessary to compete on an international level and become successful adults. With the enactment of the No Child Left Behind Act of 2001, schools' focus have centered on increased student achievement. While many states and school districts have made tremendous strides toward meeting the federally mandated legislation of the No Child Left Behind Act, too many American students are still struggling in mathematics.

While numerous studies have been conducted in the area of high school mathematics preparation and the transition from high school to college, most of these studies have focused primarily on the students' course taking, the level of the courses' rigor, quality of the high school teachers, and the high school and college relationship. Few studies have approached the situation by *talking directly with the students*. This investigation gives the students' perspective of why so many young adults are underprepared for college. Through the struggle to find the best way to prepare high

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school graduates for success in U.S. society, we often fail to ask students for their opinions, ideas, and perspectives. Could the students, possibly, have the answers to some of the biggest questions? To address this question, six recent high school graduates currently enrolled in college developmental mathematics courses in four different institutions were informally interviewed. The purpose of the interviews was to gain thick, rich descriptions of the students' mathematics educational experiences and provide themes related to underprepared college mathematics students' K-12 mathematics education. During the interviews, participants were probed for in-depth information about their previous mathematics education experiences. Thorough interviews with only six students allowed the researcher to vividly hear the students' thoughts, experiences, and perceptions of their mathematics education prior to entering college. According to Merriam (2002, p. 93), the in-depth interviews provide the researcher an opportunity to "enter into dialogue, and eavesdrop, as it were; to listen in, and capture the essence of what is perceived by the subject."

Instrumentation, Procedures, Analysis, and Findings

This qualitative investigation followed a basic, interpretive approach. The researcher served as the primary instrument for data collection and analysis, and an interview guide was used and contained the following five sections: demographic/personal, K-12 curriculum/rigor, K-12 school environment/relationships, teachers, and family. While the researcher anticipated the interviews flowing in a conversation-like manner, each section of the guide included a set of questions that kept the researcher on track during the actual discussions with the participants. During the interviews, the researcher expanded upon cues from the participants' answers to gain the thick, rich descriptions that are always important in qualitative research.

The researcher in this investigation used Miles and Huberman's (1994) Conceptually Ordered Display idea to analyze the data. The purpose of organizing the data in a conceptual manner was "to bring together items that 'belonged together'" since the researcher had "some *a priori* ideas about items that derived from the same theory or related to the same overarching theme" (Miles & Huberman, 1994, p. 127).

In an effort to gather *meaning* from the data, the researcher constructed a matrix as described by Miles and Huberman (1994). Each student's name was listed as a row heading in the matrix. Each concept discussed in the previous literature was listed as a column heading in the matrix. The students' sentences were then placed in the appropriate cells. This allowed the researcher to (a) read across the rows, giving a profile of each student and (b) read down the columns, displaying a comparison of the students' perspectives on the concepts.

Following the gathering and analysis of data from college developmental mathematics students, common themes emerged that worked together to answer the research question. These themes, working together like a story, explained how students, themselves, felt about their K-12 mathematics education. While many of the themes verified existing theory, the open-ended interview questions revealed new themes not addressed in previous studies.

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This investigation's participants perceived their previous mathematics courses as something they "just had to get through." The students did not perceive their high school math curriculum as rigorous or relevant and did not feel like their mathematics learning was valued by their teachers. An overwhelming majority of students perceived their public school mathematics educational experiences as inadequate. Many of these students were happy that they were able to take a remedial, catch-up college course, but felt their previous public schools and teachers should have done more to prepare them for college. Many of the students in this investigation also perceived their previous mathematics teachers as uncaring. Several students spoke about cheating and doing no math homework during their high school years.

The students' responses to interview questions pointed to two major areas that affected their mathematics education during their K-12 career. The two areas were labeled by the researcher as "Academic Environment" and "Social Environment." Within "Academic Environment," the common themes fell into one of four categories and created subthemes. The researcher used the following titles for the subthemes: Courses and Course Sequences, Rigor, Technology, and Relevance. Within "Social Environment," the common themes created three subthemes. These subthemes were titled Teachers, Students, and Parents. Data within each of the three subthemes were then broken into smaller groups. Table 1 gives a summary of the emergent themes and subthemes. The emerging themes extended and deepened those presented in the literature review. These themes served to reduce the void of studies concerning college developmental mathematics students' perceptions of their K-12 mathematics education.

Theme I: Academic Environment

Several factors play a role in high school students' preparedness for college and work. The school curriculum, including actual high school mathematics courses taken and the sequence in which these courses were taken, along with whether or not the high school student participated in a mathematics course during their senior year and the level of rigor of the high school mathematics courses, has contributed to students' preparedness upon high school graduation. In addition to the actual courses taken, the level of the courses' rigor affects the students' future success (ACT, 2004b). Southern Regional Education Board (SREB; 2006) and the Gates Foundation (2006) found that making the rigorous courses relevant to students' lives also positively affected learning. A fourth component, technology, has also been shown to improve student learning (Thornburg, 2000).

Academic Environment Subtheme 1: Courses and Course Sequences

Algebra II was the highest level of high school mathematics taken by three of the students. One student took no course beyond Algebra I. Only four of the students took a math course during their senior year of high school. Andrew, after taking geometry

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Table 1. Emergent Themes and Subthemes

Theme 1: Academic environment
Subtheme 1: Courses and course sequences
Subtheme 2: Rigor
Subtheme 3: Technology
Subtheme 4: Relevance
Theme 2: Social environment
Subtheme 1: Teachers
• Attitude toward and care of students
• Involvement with students
• Support of students
• Preparation of students for future endeavors
• Turnover
Subtheme 2: Students
• Belongingness
• Involvement
• Influences
Subtheme 3: Parents
• Living arrangements
• Level of education and occupation
• Attitude toward mathematics
• Attitude toward education

in the 10th grade and Algebra II in the 11th grade, was one of these students. He enrolled in a math course his senior year of high school, but, according to him, "when I got in there and saw the math they were going to be doing, I wasn't ready." Brenda took Algebra I in the 9th grade, Algebra II in the 10th grade, geometry in the 11th grade, and, like Andrew, no actual mathematics course in the 12th grade. Shawn took a mathematics course during his senior year, but only because he began his high school mathematics career with pre-algebra in the 9th grade, and followed with Algebra I during his sophomore year, geometry during his junior year, and Algebra II during his senior year. In the process of moving from school to school, Carrie's mathematics course sequence was very difficult to follow. Carrie, like Shawn, took pre-algebra in the 9th grade. She then followed with Algebra 1A in the 10th grade and Algebra IB in the 11th grade. She reported taking a "remedial math course" during her senior; Carrie never took Algebra II.

The only students taking Algebra I, geometry, Algebra II, and at least one other upper-level mathematics course were Mark and Tami. Mark reported taking Calculus I, AP Calculus, and trigonometry. Tami took Algebra I, geometry, Algebra II, and pre-calculus. Only one student in this investigation took Algebra I while in middle school or junior high school. All other students took general mathematics courses prior to high school.

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Academic Environment Subtheme 2: Rigor

Data revealed a rigor problem in high school mathematics courses. Several of the students commented, in their own ways, that their high school mathematics courses lacked rigor. While Andrew said he made Bs in both geometry and Algebra II, he added, "I shouldn't have. I really didn't do anything or learn anything. I just went to class. I just sat there and went through the lecture, and then I left. I copied and cheated." He also said, "I just never paid attention to it. I knew I was going to cheat off the next person." Andrew also noted that his teacher knew about the cheating and did not care. He said that the teacher taught directly from the textbook and then allowed the students to complete their assignments together in small groups and turn them in before the end of the class period. Brenda also discussed the issue of cheating. She said, "I cheated on somebody's work to get through it. That's the truth . . . that's how you do it if you don't understand it." Tami recalled receiving an A in Algebra I because "he [the teacher] just gave us the answers." Tami also remembered that her math teachers often just "wrote problems on the board and had the students copy them for homework." Carrie recalled something similar from her classes, "If you would complete the assignment, she would give you a one hundred even if the work was all wrong. I didn't feel like I learned anything." Brenda was the only student that reported having any homework outside of math class.

Most of the students felt that their high school math teachers prepared them for college and most were happy they were able to take a remedial college math course to fill in their gaps. When discussing her feelings about being placed in remedial college math courses, Tami said, "It made me really mad at my teachers in high school. It's like they don't tell you these things. They don't prepare you at all." When Brenda was asked if she learned a lot in high school, she said, "Not for college. I wasn't ready for college." Shawn replied to a similar question from the researcher by saying, "At my former high school, they didn't emphasize how hard college would be. I think teachers need to get you prepared."

Academic Environment Subtheme 3: Technology

Several students discussed using some technology in their high school mathematics classes. Most of the usage, however, was not geared toward acquiring higher-order thinking skills. Andrew recalled his ninth grade math teacher teaching primarily with the overhead projector and computers. The computer work, however, was limited to "basically doing the book problems on a computer." Mark's teachers used the textbook, worksheets, and some technology to teach new material. Mark said in the interview, "I like math and computers so it just made me like it more and have more fun." Carrie's experiences with technology in high school mathematics classes were similar to Andrew's. Carrie mentioned going to the computer lab to take notes. She also said that the while the teacher was "there," he did very little teaching and provided little

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assistance to the students. Carrie, like Mark, enjoyed the technology that was made available. She said, "I kind of liked it because it was independent and I could go do the work when I wanted to even though it didn't count because he didn't want to grade it."

Academic Environment Subtheme 4: Relevance

Few of the students felt that their high school mathematics teachers made the lessons interesting and applicable to everyday life. They felt they did not receive opportunities in their high school mathematics classes to see the purpose and relevance of their studies. When asked if teachers applied mathematics to real life, Brenda said, "No. It was like 'why do I need this?' I don't use this in the real world." While Andrew's classes did not incorporate activities to show the relevance of mathematics, he felt that this would have benefited him. During the interview, he stated, "It [participating in activities] would have helped. Activities would have made it more interesting." The discussion of relevance with Mark was similar to the discussion with Andrew. Mark remembered rarely participating in class activities or projects. The only class in which Mark recalled the teacher relating mathematics to everyday life was trigonometry. Mark said, "In trig class, we talked about construction and levels and things. It was just spur of the moment." Mark, like Andrew, would have appreciated more opportunities to see the relevance of the mathematics topics he learned. He said, "It gets the students involved and they learn if they get involved."

Students did not have much of an opportunity to participate in hands-on math activities while in high school. However, several of them remembered having fun participating in activities in their elementary mathematics classes. Brenda said, "We did some activities. That was great. I learned much better and it was fun when we did activities." Shawn had fond memories of a "facts mastery" game he and his classmates played in elementary school. Carrie, Tami, and Andrew, too, played games in their early math classes. Carrie said, "I like the activities because I like hands on, you know, shiny objects." Andrew said, "I'm the kind of learner that likes hands on so activities and things like that just make me learn better."

Theme II: Social Environment

For this investigation, the social environment included relationships involving teachers, students, and parents. As previously mentioned, relationships, belongingness, teacher and parental support, and teacher quality have been shown to affect students' learning and their preparedness for future endeavors. This investigation's findings supported previous findings.

Social Environment Subtheme: Teachers

For most of the participants, high school mathematics classes were taught by teachers who lacked a caring attitude. Three of the six students actually commented that their

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teachers were uncaring. Carrie said, "He [one of her high school mathematics teachers] didn't care. He was trying to start a church and he was working on the church stuff." Mark, when asked what his high school math teachers could have done to better prepare him for life and for college, said, "Care." Brenda said, "Mr. Sims, the basketball coach in high school was not patient and he wasn't very caring."

For the most part, the interviewed students felt that their high school math teachers did not enjoy teaching. Referring to a former math teacher, Brenda said, "She was okay, but she didn't seem to like kids and she was hateful." When discussing her high school classes and teachers in general, Brenda said, "I was afraid to go into class. The teachers were always grumpy and hateful. It depended, though, on who you were. If you were an athlete, it was fine." Mark felt his teachers "were just there to get paid and they didn't want to teach." He also commented, "The teachers acted like they pretty much didn't like the kids." According to Andrew, "They [his eighth and ninth grade math teachers] didn't seem like they wanted to be there to teach. My ninth grade teacher was rude and we bumped heads." Tami, like Brenda, Mark, and Andrew, did not feel her teachers were interested in the students. She said, "The teachers showed up late for classes and they didn't seem to like kids." Tami also said that she felt that all her high school teachers "just wanted to get us [the students] though" and they "just seemed to want to get us through the hour and then the next class would come." Shawn's memories of his high school math teacher were positive. However, he did say that he wished they had been more interested in him. "Athletes are important and they get treated better. They just get treated better and that's not right," said Shawn.

Several of the students had good memories of their elementary teachers. Carrie discussed the positive influence her second grade teacher had and continued to have upon her life. Tami commented that her elementary teachers "made us feel comfortable and excited." Mark, too, had a positive experience in elementary school. He felt those teachers had a good attitude toward math and genuinely cared about their students.

Two students discussed their positive experiences while in college math classes. Tami said, "my college teachers have been more easy-going. They explain things really well and they don't go on until everybody understands it." Tami also spoke of her college teachers as being more patient than she remembered her high school teachers being. Referring to his college math teacher, Shawn said, "She was sociable. I like that. I wasn't afraid to ask questions."

In most of the students' former mathematics classrooms, the teachers taught primarily by lecturing, giving notes, and working out problems on the chalkboard. When asked what would have made the classes better, Tami replied, "Get us involved in what we were doing. Listening to lectures, taking notes, and taking tests is really hard for a kid when it is math and it is the same numbers over and over. You just lose interest." Mark, too, said that his teachers "just wrote the assignment on the board." He also recalled that the teachers "just gave us the material and went to their desk and piddled or graded papers."

Several of the students discussed having difficulty asking their high school math teachers for help. Brenda said, "If you asked questions, she [high school math teacher]

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acted like you should already know it, so we hardly asked her anything." Brenda had different feelings, however, toward a middle school teacher. She said, "I had a good teacher and she would actually help me if I needed help. I could always go and help her and she would help me." Tami's high school experience was similar to Brenda's. She said, "They [the teachers] would say, 'If you have questions, just ask.' Then, they would say the exact same thing they had just said and we [the students] still didn't understand." When discussing teacher support with Mark, he said, "You would probably have your hand raised for thirty minutes. By the time they [the teachers] acknowledged you, it would be time for class to change."

Very few of the students recalled their high school teachers doing something to prepare students for the ACT exam. Mark reported some of his teachers occasionally mentioning that certain concepts might appear on the exam. While Brenda's teachers did nothing to prepare students, she was able to participate in an ACT prep workshop, which she felt was very beneficial.

Tami and Shawn discussed, in depth, the high turnover rate of their high school math teachers. Tami said the math teachers in her school changed every year.

> Every year there were different teachers. Every year there was a new teacher for a new subject. There was never the same teacher. If there had been more consistency every year, it would have helped. The kids would have known what was going to happen.

Mark had similar comments. When asked to describe his high school math teachers, he said, "our math teachers changed every year so I can't really say much. We [the high school] had some disputes and we switched teachers and switched teachers."

Social Environment Subtheme 2: Students

Shawn, Mark, and Andrew had fond memories of their high school days and felt a sense of "belongingness." While feeling comfortable in the smaller high school he attended, Shawn discussed that there were numerous "cliques" in the larger school he attended prior to high school. At the smaller school, Shawn said there were only two "cliques" and those were "the athletes and everybody else." Carrie also had unpleasant school experiences prior to high school. She spoke of chaos and fear dominating her middle school. Brenda remembered not feeling a part of her junior high school. She said that students were "really ugly" toward her and that she hated school. Tami's feelings toward middle school were good. She said, "I liked junior high because it was a smaller building and we had a seventh grade hall and an eighth grade hall. It was smaller and there weren't as many students."

Both Carrie and Brenda had poor experiences in elementary school. Carrie reported having a poor attitude and being "unruly" during this time. She felt that more structure and a more secure home life would have positively affected her education. Brenda's home life also affected her educational life. Being molested and dealing with numerous

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family illnesses caused her to struggle with relationships within school. She remembered her young classmates making fun of her and her teachers not attempting to stop it.

Most of the student discussed being heavily involved in extracurricular school activities. Shawn, Andrew, Mark, Tami, and Brenda all participated in extracurricular activities during their high school years. These activities seemed to play a significant role in the students' lives. Shawn participated in football and wrestling; Andrew played basketball, football, and soccer; and Mark was involved in football, basketball, and was on the cross-country team. Tami spent a considerable amount of time with volleyball, while Brenda was a cheerleader and the school mascot. Both Shawn and Andrew mentioned athletics influencing their motivation for achieving good grades. While volleyball was helping pay for Tami's college education, involvement in the sport had some negative effects for her during high school. The involvement caused her to miss a considerable amount of school and, because of an injury suffered while participating in the sport, she was hospitalized for several weeks causing her to miss even more class time.

Four of the six students, however, mentioned that a family member was the most influential person in their lives, and one student said "teacher." Andrew said that his older brother, now a teacher and coach, has influenced his life more than anyone else. He said, "My brother—he's always the first person I talk to about anything before I go to my parents." Mark said his parents have influenced him the most throughout the years. Tami felt that her grandmother, a former kinesiology teacher, had played the most influential role in her life. "She [Tami's grandmother] helped me figure out what I wanted to do and she always helped me do it," said Tami. Carrie's uncle affected her life the most. "He always pushed me. He was working on his PhD right before he died," said Carrie.

Social Environment Subtheme 2: Parents

Three of the six students came from divorced homes. Carrie spent time living with each parent during her adolescent and teenage years. Tami lived with her mother after her parents' divorced, and Shawn resided with his father. Both Tami and Shawn spoke of having poor relationships with one of their parents. At the time of the interview, Shawn had not spoken with his mother in 9 months, and Tami had not heard from her father since her high school graduation. While Carrie still held a relationship with both parents, she felt her mother's lack of structure and boundaries contributed to her underachievement in school.

Three of the students had at least one college-educated parent. Andrew's father held a doctoral degree and was a college professor, while his mother was a registered nurse and owner of a health care facility. Carrie's father was a retired teacher, while her mother "did medical records at a medical place. Tami's mother held a degree in accounting. Her father, at the time of the interview, was working as a preacher.

Brenda, Mark, and Shawn's parents held no college degrees, but all completed high school. Brenda's mother was a medical aid, and her father was a retired truck driver.

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Both of Mark's parents held military backgrounds, and his mother also worked part-time in a grocery store. While these three students' parents did not attain a college diploma, the students all mentioned that their parents had either attempted college or had discussed, with them, the importance of college. Mark said that his father wished he, himself, had gone to college so he "wouldn't be doing the hard job that he is doing now."

Most of the students reported that both their parents had a positive attitude toward mathematics and toward education in general. Tami said, "My mom is an accountant, so she made us [Tami and her sister] do it [math]." According to Andrew, "My father loved math—he loved school, period. He yelled at me everyday if I didn't do math right, but that's just because he loved school."

Three of the students discussed their mothers having poor attitudes toward mathematics. Brenda said, "My mom wasn't good at math. She didn't like it and thought it was stupid." Andrew, too, said, "She [his mother] hated math." Carrie's mother attitude was not good toward math or education. "She [Carrie's mother] really wasn't into English and math and stuff so I was kind of on my own. I hate to say this, but it was only important to my mom when the teacher called," said Carrie.

All six students' parents had high educational expectations for them. While Brenda's parents' goal for her was "finish school and settle down and have a family," Carrie's dad's expectation for her was to complete her associate's degree, transfer to a 4-year institution and earn a degree in education, and then possibly attain a master's degree. Andrews's parents' expectation was to "graduate from college" and Tami's was to "graduate from college and get a job." When asked about his parents' expectations for him, Mark said, "Try your best."

Findings Applied to Research Question and Literature

Academic Environment

Courses and course sequences. "Some courses and course sequences better prepare students for postsecondary level work than others" (ACT, 2005, p. v). According to ACT (2005, p. 8), "Students increased their chances of meeting the readiness benchmark for college algebra by taking Algebra I, geometry, Algebra II, and at least one other upper-level mathematics course such as trigonometry." SREB (2001, p. 4) suggested that students take "at least four credits in mathematics, including Algebra I, geometry, Algebra II and a higher-level mathematics course, such as trigonometry, statistics, pre-calculus, or the College Board's Pacesetter Mathematics." Four of the six students in this investigation did not follow the recommendations set forth by ACT and SREB. Mark and Tami were the only students who reported taking an upper-level mathematics course beyond Algebra II.

Previous studies would suggest that a large part of the reason behind Andrew, Brenda, Shawn, and Carrie being placed in college developmental math courses lay

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with the courses they took, or did not take, while in high school. However, Mark and Tami both did take the recommended high school mathematics courses but were still enrolled in developmental college mathematics courses. Mark reported that while the college suggested he enroll in a credit-bearing course, he, himself, made the decision to enroll in a developmental course. Tami was the only student who took 4 years of high school math, which included a course beyond Algebra II, and was still required to enroll in a college developmental mathematics course.

Not only did most students in this investigation fail to take an advanced mathematics course beyond Algebra II, many students did not take a mathematics course during their senior year of high school. These data were very similar to data from the U.S. Department of Education (1997), which reported that in 1992 only 43% of high school seniors reported themselves to be in demanding college preparatory programs. SREB (2001) made comments similar to those made by the U.S. Department of Education. SREB (2001) stated,

> When students have not taken challenging courses in certain subjects in more than a year, they often struggle in those subjects when they enter college. To make sure that major subjects are fresh in students' minds, schools need to set a goal that all seniors will take at east three academic courses, including a high-level mathematics or science course. (p. 6)

Wimberly and Noeth (2005, p. 4) stated, "students who take a challenging curriculum, beginning in the middle school, tend to perform better academically in high school and are better prepared for college than those who take less rigorous courses." In this investigation, only one student took Algebra I while in middle or junior high school. All other students took general mathematics courses prior to high school.

Rigor. "The number of students who are not ready for college (or the workplace) has recently been described as 'nothing short of a crisis'" (ACT, 2005, p. vi). ACT (2005, p. 15) also stated that "readiness for postsecondary coursework depends on the rigor of the high school courses taken." Students in this investigation reported low levels of rigor in their high school mathematics courses. The findings were similar to findings from Bridgeland's study (Bridgeland, Dilulio & Morison, 2006). This investigation of U.S. high school dropouts found that students may have dropped out of school because they felt unmotivated and felt that school was boring. Of the survey respondents in Bridgeland's study, 69% indicated they would like to have been inspired while in school. Young adults in the focus group interview portion of that study consistently said their classes were boring and that their school did not do enough to make them work hard.

Findings in the current investigation were similar to findings in Bridgeland's study. Several students in the current investigation mentioned not working hard, and even cheating, in their high school mathematics classes. Andrew discussed that his teacher knew the students were cheating but did nothing about it. While Tami and Carrie did

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not mention cheating, both girls discussed being given grades for "copying problems off the board" and "getting a one hundred even if the work was all wrong."

Technology. "Teacher's professional development in technology and the use of computers to teach higher-order thinking skills were both positively related to academic achievement in mathematics and the social environment of the school" (Wenglinsky, 1998, p. 3). According to Thornburg (2000), it is not technology usage that has the tremendous impact on students, but it is *how* the technology is used. Few students in this investigation reported having the opportunity to use technology in any way while taking high school mathematics courses.

The students mentioned several times that they enjoyed technology and that using computers more would have made their math courses more "fun." The time has come for educators to realize that today's students are very different from yesterday's students. Methodologies that may have been adequate for former generations are no longer appropriate. As Zahorchak (2006, p. 7) stated, "Our students live in a digital world, and schools must adapt instruction to complement learning in that environment."

Relevance. "Young adolescents need varied learning activities linked to challenging academic content and opportunities to use new skills and concepts in real-world applications" (SREB, 2006, p. 3). Darling-Hammond (1999, p. 19) said that "students learn best when new ideas are connected to what students already know and have experienced and when students use real-world problems to apply and test their knowledge." Very few of the students involved in this investigation reported their high school mathematics teachers making the lessons interesting and applicable to everyday life. When asked if high school teachers applied mathematics to real life, one of the students said, "No. It was like 'why do I need this? I don't use this in the real world.'" The students also stated that they had few opportunities for hands-on activities.

Social Environment

Students. The National Association of Secondary School Principals (NASSP; (2004) supports a personalized environment. One of the components of a personalized environment, according to the NASSP, was opportunities for students to develop a sense of belonging to the school. Only about half of the students felt they belonged in high school.

Those involved with students in educational settings might wonder if extracurricular activities and influential people help students feel more accepted and a part of their institutions. Athletics and sports did play a large role in several of the students' lives. In addition, four of the six students reported a "parent" played the most influential role in their life.

Teachers. Research (Harvey & Housman, 2004) indicated that student achievement improved when additional academic support and assistance were provided. ACT (2004b) found good rapport between teachers and students to be a common theme leading to increased student achievement. Research from the NASSP (2004) found that all students performed better when involved in a nurturing and caring environment.

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Three of the six students commented that their high school math teachers were actually uncaring. However, they had very positive stories to tell about their elementary and college teachers. Carrie discussed how she still maintained a relationship with her second grade teacher. Tami spoke about her college math teacher as being very patient.

While not discussed in the research, two students commented at length about the high teacher turnover rate at their previous high school. Tami said,

> Every year there were different teachers. Every year there was a new teacher for a new subject. There was never the same teacher. If there had been more consistency every year, it would have helped. The kids would have known what was going to happen.

Parents. In *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Beaton et al., 1996), 33% of the students reported that the highest level of education for one of their parents was university completion; 54% reported that the highest level of education for one of their parents was high school. The current investigation's findings were similar; three of the six students had at least one college educated parent.

Kafoussi (2005, p. 1) stated, "students' home experiences influence their beliefs about mathematics as well as their mathematical activity in the classroom." Rongjin & Leung (2005, p. 1) found that "parental educational expectations for their children and involvement in their children's mathematics learning were two major factors which influenced children's educational expectations for themselves, attitudes toward mathematics, and self-confidence in doing mathematics." For the most part, the students in the current investigation said their parents had a positive attitude toward mathematics. These highly positive results were surprising to the researcher because these students had not previously demonstrated high levels of success in mathematics courses. The students' parent's overall expectations for them were high, and when asked about parental expectations, most of them said their parents expected them to attain a college degree and find a good career.

Significance

This investigation was based on the assumption that educators hold the responsibility of educating students at a level that ensures that all students will be college and work ready upon graduation from high school. Findings from the PISA (Design Science, 2006), TIMSS (Design Science, 2006), and ACT (2005) revealed the serious problems with our current educational system, especially in the area of mathematics. While there has been a significant amount of research conducted over the past several years, most has focused on quantitative data (e.g., test scores, grade point averages, and college placement exams) and on data collected from successful students and successful scores. Very little research has approached the problem from the underprepared student's perspective. This investigation was designed to go to the underprepared college

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to gain an understanding of their perceptions as to why they were not mathematically prepared for college-level coursework and what might have helped them acquire the mathematical knowledge necessary to seamlessly enter postsecondary education. The researcher wanted to hear these students' stories to find possible avenues to pursue to improve the education for students in grades K-12. By interviewing and analyzing data from six students, the researcher gained in-depth information.

Implications

This investigation was relevant to a variety of people in the field of education. Implications that follow were given for teachers, school leaders, and those who work in teacher and administrator preparatory programs. In addition, implications for future research were also noted. Each of these was intended to imply the practical use of this investigation and how practitioners may apply it in their current setting.

Teachers

The students in this investigation spoke about their high school teachers continually. The most discussed topic was the teachers' level of care toward the students. This investigation's data and previous research indicate that high school mathematics teachers should make rapport building a top priority. In this investigation and numerous studies (ACT, 2004b; Barth, 2003; Harvey & Housman, 2004; SREB, 2006), successful students discussed the effect quality, knowledgeable, caring, and supportive teachers had on their mathematics learning.

As Lambert and Lowry (2004) suggested, high school mathematics teachers must also keep communication with the students' parents a priority. Teachers should not allow parents to continue to excuse their children's lack of mathematical success by stating that they, themselves, are not and were not mathematically knowledgeable. As Rongjin and Leung (2005) suggested, teachers must work with parents to change the attitude toward and view of the mathematics discipline. After building rapport with both their students and their students' parents, teachers should discuss the importance of a strong 4-year high school mathematics background. "Parents play an important role in supporting their children's course-taking and career choices (Scarpello, 2007, p. 35).

Teachers must differentiate their instruction and use all available resources. Growing professionally is essential in meeting the changing needs of today's students. "Effective professional development for teachers should engage them both as learners and teachers, allowing them to struggle with each role's uncertainties" (Darling-Hammond, 1997, p. 4). Teachers must be able to incorporate hands-on and cooperative projects within their classrooms and technology must be used in appropriate manners.

High school math teachers working collaboratively with college and university math teachers would be beneficial. Learning what is expected at the postsecondary

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level and finding out which skills college students are lacking will assist high school mathematics teachers help students make the transition into college more easily.

Students in this investigation repeatedly mentioned the low expectations of their high school math teachers. Teachers must challenge students and work to ensure that there is a high level of rigor in their teaching. As was seen in the previous chapter, students seldom appreciate "easy" classes. As Darling-Hammond (1997) states, teaching that meets the needs of the 21st century includes

> engaging students in activities that can help them become writers, scientists, mathematicians, and historians, figuring out how children learn, what they actually understand, and what they can do, and understanding how children develop, and knowing many different strategies to help them learn. (p. 1)

To ensure that teachers have the knowledge and skills necessary to develop a rigorous and relevant curriculum, SREB (2001) suggested several professional development programs. "'Applied Strategies for Mathematics' helps teachers use hands-on strategies and real-world problems to teach students mathematical procedures as well as mathematical concepts and how these concepts relate to the world around them" (p. 8). "The 'Project-based Learning' workshop helps teachers learn how to engage students in complex, real-world problem-solving that is academically rigorous, relevant and empowering" (p. 8). While "Applied Strategies for Mathematics" and "Project-based Learning" are SREB-owned programs and may not be available to all teachers in all school districts, many other progressive, research-based professional development opportunities are available to teachers interested in improving their instruction and their students' learning.

School Leaders

In high schools, administrators hold the ultimate responsibility of analyzing and adapting graduation requirements to meet the needs of a changing society. ACT recommended that schools require all students to take specific college preparatory courses in English, mathematics, science, and foreign language. At the state and/or district level, graduation criteria should be defined by specific courses and course sequences (rather than number of credits) and should require that all students take, at a minimum, Algebra I, geometry, Algebra II, and at least one other advanced mathematics course beyond Algebra II. "If school leaders and teachers do not lead in developing a plan for enrolling more students in challenging academic courses in high school and middle grades, it will not happen" (Bottoms, 2006, Slide 12).

It is essential that administrators work collaboratively with teachers when reevaluating the school's curricula and increasing rigor.

> District and school leaders must create an organizational structure and process that ensures continuous involvement with faculty on what to teach, how to teach,

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> what students are expected to learn, how to assess what they have learned, and how district and school leaders support each other, the students, the students' parents, and the community. (SREB, 2006, p. 4)

"District leaders must encourage a curriculum review and alignment process that compares all curricula to state, national and international standards," and as a result, develop "a set of conditions and performance standards defining the quantity and quality of work expected at each grade level throughout the system" (SREB, 2006, p. 4). ACT's research (2004b, p. 74) echoed SREB's by stating that to ensure rigor within the curriculum, "district administrators and staff must reevaluate the content of college-oriented curricula as currently taught." Research (ACT 2004b; SREB, 2006) suggests that administrators and teachers work together to adopt textbooks, align curricula, and stay abreast of the research. Bottoms (2006) said,

> Students' behavior and attitude toward school changes when school leaders agree to do whatever it takes to get students to grade-level standards, prepared for challenging high school studies and for postsecondary studies and careers. Achievement goes up, graduation rates increase and students become more engaged when leaders set higher expectations and support students to meet them. (Slide 15)

In the Pathways to College Network [PCN] study (2003), six high schools were examined to understand the strategies they used to increase college preparedness and access for underserved students. Researchers in the study said,

> During the course of our research, we found three conditions common to all six schools that appeared to have an impact on the school's ability to increase the college aspirations and access for underserved students: 1) administrative leadership is critical to change, 2) schools increase student success when they establish a school culture focused beyond the high school diploma and regularly communicate high expectations to students, and 3) school communities build the capacity for change by developing a common vision, providing coherent learning opportunities, and making resource use flexible. (PCN, 2003, p. 55)

Administrators ultimately hold the responsibility of ensuring that teachers teach the curriculum in a manner making it relevant to the students. According to Tirozzi (2005, ¶ 3), students should "see their learning as meaningful, relevant, rigorous and challenging, ensuring their success both within and beyond high school." Breaking Ranks II suggests that when teachers design high-quality, rigorous work, encourage that students persist, students graduate with the knowledge, critical thinking and problem-solving skills required regardless of the postsecondary path they choose (NASSP, 2004).

Research suggests that administrators hire knowledgeable and experiences teachers. According to Darling-Hammond (1997, p. 6), "a major challenge for principals

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will be to find, select, develop, and retain well-prepared teachers to fill more than two million vacancies expected over the next decade due to growing student enrollments and increasing retirements." Finding and hiring well-prepared teachers is, however, sometimes impossible, especially in the mathematics discipline. It is, therefore, the administrator's responsibility to provide support for professional development (Darling-Hammond, 2004). "District and school leaders must provide leadership and financial support for professional development directly connected to academic standards and student achievement" (SREB, 2006, p. 4). "Developing more skillful teaching is a *sine qua non* for attaining higher and more equitable achievement for students in the United States" (Darling-Hammond, 2007, p. 41). According to SREB (2006, p. 4), "Professional development includes support for teachers in the classroom as they implement teaching practices with demonstrated effectiveness." In addition, "local school boards should help teachers without majors in their subject areas upgrade their content knowledge through academic courses" (p. 4). Learning communities also provide avenues for teachers, both in-experienced and experienced, to grow professionally. As Darling-Hammond (1997, p. 6) said, "Principals play a major role in supporting learning for all members of the school community—teachers, other staff, parents, students, and themselves." According to Darling-Hammond (1997),

> Learning organizations provide ways for everyone in the school, regardless of role, to form teams of adults who work with and help one another in structures that enable them to share responsibility for student learning. In addition, strategies like study groups, peer coaching, research-into-practice teams, collective development of learning standards, and collective assessment of student work ensure that learning is focused and ongoing. In this way, the teacher's day-to-day work becomes a form of high-quality professional development. Characteristics of healthy professional communities include the ability to embrace diversity at all levels, the existence of problem-solving structures, regular participation in critical review and reflection, a culture that encourages trust and teamwork, and a belief in ongoing renewal. (p. 7)

Administrators can also help faculty meet the higher demands placed upon them by providing common planning times for teachers to work in teams, both vertically and horizontally, to plan curricula and develop scope and sequence charts. Supplying teachers with the necessary instructional materials for implementing new curricula and teaching methods is likely to have a positive effect on both teaching and learning. SREB (2001, p. 9) requires all High Schools That Work schools to "agree to commit the time, personnel and financial resources to enable teachers and leaders to take the steps necessary for changing school and classroom practices and raising student achievement." School leaders should develop teams of teachers and provide them time and support to work together. Teachers should also be provided with money, materials, and resources to implement the changes. According to SREB (2006, p. 1), school leadership should focus on "supporting what and how teachers teach by providing common planning time and professional development aligned with school improvement

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plans." According to Darling-Hammond (p. 6), principals should ask, "What do teachers need to know and be able to do to link the needs of each learner and the attainment of challenging learning goals?"

The Pathways to College Network (2003) clearly demonstrated the important role leaders play in implementing change within their school when they said:

> Today's world demands that educational systems support high achievement and the development of lifelong learning skills for all students, regardless of background. A comprehensive and collaborative approach is needed to reach the large numbers of underserved students who, with equal learning opportunities, encouragement, and support, are capable of preparing for and succeeding in college. (¶ 1)

Personalization has been discussed as

> providing students with opportunities to develop a sense of belonging to the school, a sense of ownership over the direction of one's learning, the ability to recognize options and to make choices based on one's own experience and understanding of the options. (NASSP, 2004, p. 67)

SREB (2006, p. 3) suggested that "schools provide a structured system of instruction and extra help that . . . supports teachers in forming nurturing academic relationships with students to improve students' work and achievement." While personalization most usually occurs between students and teachers, the personalization seed must be planted and nurtured by the school administrator. NASSP (2004) listed practices for administrators to consider when beginning the implementation of personalization. NASSP (2004, p. 68) included the following practices:

- Creating structures so that students cannot remain anonymous for 4 years
- Establishing schedules and priorities that allow teachers to develop an appreciation for each student's abilities
- Offering parents, families, and community members opportunities for involvement in students' education
- Providing students with opportunities to demonstrate their academic, athletic, musical, dramatic, and other accomplishments in a variety of ways

Caring is a component of personalization. In a research study, ACT (2004b, p. 73) found that when teachers "were constantly taking and asking questions, and otherwise checking to make sure their students were understanding," the students were more prepared for postsecondary education. Nel Noddings has discussed teaching and caring in numerous articles. When discussing the practice of teaching, Noddings (2003) said, "schoolteachers accept some responsibility for the development of students as whole

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persons. . . . We affect the lives of students not just in what we teach them by way of subject matter but in how we relate to them as persons" (p. 249). Noddings (2003) continued,

> Not only must a teacher acquire and continually extend her store of broad cultural knowledge, she must also be committed to establishing and maintaining relations of care and trust. This is necessary if teachers are to meet responsibility for the development of their students as whole persons. Relations of care and trust also form a foundation for the effective transmission of both general and specialized knowledge. But relations of care and trust are ends in themselves, not simply means to achieve various learnings. (p. 250)

By addressing curriculum rigor and relevance, relationship building, developing quality teachers, and increasing parental involvement, administrators may improve achievement and preparedness for all students. When school leaders were involved in reforming high schools, schools helped students "become productive adults . . . equipped with 21st century skills" (Priesz, 2006, p. 36). "High school administrators have a particularly critical role to play in the school reform movement" and "as leaders on the ground in their schools, administrators see the challenges and successes of high school transformation directly" (Housman, 2006, p. 14). "Administrators have the potential to create lasting change in their high schools, and that will truly improve the outcomes for youth in their communities" (p. 14).

It is evident that administrators in every building, in every school, and in every U.S. school district should immediately begin constructing their action plans to provide all students the best opportunity to be successful adults able to compete globally. When beginning the process of change within one's school, leaders must stop believing that "some students are destined to fail and instead embrace the philosophy that, in the right environment and with the right support, most students can learn challenging material" (SREB, 2001, p. 2).

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Bio

Paula Schornick has 16 years of experience in education as a high school mathematics teacher, college mathematics instructor, high school administrator, and university professor. After completing her PhD in school administration two years ago, she began teaching university school administration graduate courses.

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