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HISPANIC STUDENTS MAJORING IN SCIENCE OR ENGINEERING: WHAT HAPPENED IN THEIR EDUCATIONAL JOURNEYS?

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National statistics clearly demonstrate an underrepresentation of minorities and women in the fields of science and engineering. Using Seidman's in-depth interviewing method, 22 Hispanic students, 12 female and 10 male, who were majoring in science or engineering were interviewed. These students were observed in their college science or engineering classes, their high school and college transcripts were analyzed, and they participated in a focus group. What made a difference in the educational journeys of these 22 students so that they could succeed in majors that have historically discouraged female and minority students? Seven themes emerged: family support, an honors program, a challenging and interactive curriculum, college preparation in high school courses, caring and kind teachers, small class sizes, and small communities. Educators must take note of these themes, which made a lasting difference in the students' futures, enabling them to choose science or engineering as their fields of study.

INTRODUCTION

By simply noting the gender and ethnicity of all newborn infants, one can easily predict statistically who has the better chance of becoming a scientist, a mathematician, an engineer, or a member of the medical community. Our educational system has systematically discouraged students of color and female students from continuing in science and math. These students are a majority of our nation's schoolchildren, but they are being shortchanged in terms of educational opportunities. Many administrators, teachers, counselors, and even some parents have eliminated many career options for these students as they have progressed through their educational experiences.

From preschool to the last year of formal schooling, all students undertake educational journeys by taking a variety of routes. Some journeys are long, whereas others are short. Many students have an array of routes available for exploration, whereas other students have limited choices. When science education is taught in the traditional manner, the science, engineering, and math routes seem to be closed to students of color. It is important that educators make changes so that all routes are open to all students to explore and discover as they travel the educational journeys of their lives.

Research has shown that there needs to be a change in curricular content and teaching techniques (Bybee, 1997; Guillaume, Yopp, & Yopp, 1996; Hurd, 1997; Lee & Fradd,

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1995) to attract students of color and female students to science or engineering. Change in the contents of curricula and pedagogical techniques will lead to a diverse population in the community of scientists, one that represents the same diversity with regard to gender, ethnicity, and class that is seen in the U.S. population as a whole (Dilg, 1999; Rosser, 1993).

In response to this demand, science standards and benchmarks have been written to encourage the implementation of teaching strategies and science curricula that will give each and every student an opportunity to succeed in science. Current reform has often been equated with publications such as *Benchmarks for Science Literacy* (1993) and the *National Science and Education Standards* (National Research Council, 1996). These documents exemplify national science education policies addressing aspects of science education such as curricula, instruction, teacher education, program implementation, assessment, scientific literacy, and equity issues. Educators must realize that the documents are not perfect, as Rodriguez (1997) maintained in his article; even the *National Science and Education Standards* must be strengthened with more evidence in support of the equity issue.

Equity pedagogy has been proposed as an essential element of science curricula (Banks & Banks, 1995). Science educators, politicians, administrators, and the public are getting on the bandwagon to promote the concept that science must be accessible to all students. Yet students of color are not choosing to major in science. In over 50 years, there has been only limited success in improving science education (Bybee, 1997). The statistics verify that students of color are not majoring in science, are not taking advanced science courses, and generally do not like science (Rakow & Bermudez, 1993). National data show that approximately 40% of college undergraduate students leave engineering programs, 50% leave physical and biological sciences, and 60% leave mathematics, and these percentages are disproportionately greater among female students and students of color (Seymour & Hewitt, 1997; Smith & Hausafus, 1998).

Gaps still persist in science achievement between men and women and between White students and students from other ethnic groups (National Science Foundation, 1996). In response, thousands of dollars have been poured into making scientists out of schoolchildren, but little difference has been documented (Sims, 1992). Despite these widespread calls for reform and the money spent, traditional practices in science classrooms have been robust and resilient to the forces of change. The response has been "curriculum tinkering, supported by window dressing slogans, instructional gimmicks, faceless resolutions, and onslaughts of unstudied rhetoric" (Tobin & McRobbie, 1996, p. 224). Therefore, science educators have not made it possible for all students to feel comfortable and accomplished in science classes across the United States. In every reform theory, changing the focus of the enacted science curriculum from the needs of the discipline to those of the learner is emphasized (Sarawa-Shore & Garcia, 1996). Science educators must develop appropriate activities that incorporate engaging and interesting experiences with meaningful connections for learners, especially students of color (Bybee, 1997; Rakow & Bermudez, 1993). Concrete progress needs to be made in providing opportunities for all learners to have access to science (Garcia, 1999; Hoffman & Stage, 1993; Navarro & Natalicio, 1999).

There are reasons for failure, and "in the last twenty years research educators have gathered a great deal of information on the social and institutional factors that negatively affect the progress of underserved students in science" (Rodriguez, 1998, p. 214). Failure is used in the context that the science class failed the student, and the student did not take advanced science courses in high school or major in science in college because of his or her experiences in the science classes.

Because Hispanic students are the least educated major population group in the United States because they are more likely to drop out of high school and not attend college (Gandara, 1995), this study is very relevant. For example, in California and Texas, where more than one third of the college-age population is Hispanic, only 11% to 13% are enrolled in 4-year colleges (Gandara, 1995). With the high Hispanic student dropout rate, it is no wonder that there is such an underrepresentation of Hispanics in science and engineering departments at the university level.

Taking a more positive approach, I wanted to talk with Hispanic university students, male and female, who have succeeded against all odds and barriers to find places in the scientific or engineering community. The basic unit of education is the students, and I met with them face to face to understand their educational worlds. It is time for their stories to be heard and to affirm the importance of each individual's contribution to education. By simply navigating through the system of science and math education and battering down the barriers, these students of color have shown themselves to be remarkable individuals, and their stories are worth telling. By understanding the students' points of view, this qualitative research study provides science educators with new insights into how science education can be improved to provide an opportunity for all students to succeed in the science classroom.

METHODS

Twenty-two Hispanic students who were majoring in science at a state university in the southwestern part of the United States were interviewed using Seidman's (1998) in-depth interview technique.

In-Depth Interviewing

Students of color who have succeeded in science have stories to tell. As Vygotsky (1987) stated, every story is "a microcosm of their consciousness" (pp. 236-237). This consciousness is the doorway to the social and educational issues that are based on the concrete experiences of the people interviewed. Many researchers and educators have documented the barriers to success in science for any student who is not a White man (Alva, 1991; Crawford, 2000; Gandara, 1995; Hurd, 1997; Lynch, 1998; Rakow & Bermudez, 1993). By interviewing 22 successful students of color, 12 female and 10 male, I was able to find meaning in their stories and understand how, against all odds, they did so well in science and engineering.

The students who were interviewed as part of this study were volunteers, and I recruited these volunteers using a variety of strategies. By attending meetings of clubs of which the majority of members were students of color; attending science classes; and asking for help from specific departments, such as Chicano Studies, the Alliance for Minority Participation, Black Programs, the American Indian Program, the McNair Program, and the Minority Access to Research Careers Program, I recruited 22 Hispanic students (1 sophomore, 7 juniors, and 14 seniors), who completed the three-part interviewing process. The group consisted of 12 female Hispanic students: 6 majoring in engineering, 2 in biology, 2 in biochemistry, 1 in microbiology, and 1 in nutrition. Of the 10 male Hispanic students, 7 were majoring in engineering, 1 in biochemistry, 1 in chemistry, and 1 in animal science.

For this qualitative study, Seidman's (1998) interviewing technique, which consists of three 90-minute interviews, was used. The purpose of the first interview, according to Seidman, is to get to know a participant by asking him or her to describe early experiences with school, family, social groups, work, extracurricular activities, and the everyday routines of life. I was careful to help each participant become comfortable in the first interview and realize that I was not there to criticize or evaluate what had happened in his or her educational journey.

The second interview concentrated on details of what it is like to be a science or engineering major at this state university in the southwestern part of the United States. Each participant was asked to share what encouragement he or she was receiving to continue in science and math and to connect these experiences with his or her earlier stations and schools along his or her journey. Were there study groups? Did the participant interact regularly with professors or students? How were science and math being taught at this university? This list of questions unfolded as each interview unfolded.

The third interview provided time to reflect on the meaning of students' entire educational journeys in science and what led them to succeed in science and math. The participants were willing to look at where they were presently, where they had been, and where they were going. They thought about how all of the factors had affected them in their studies (Seidman, 1991).

For this third interview, students also were asked to reflect on what learning environment would encourage more Hispanic students to take the route that they had chosen. I asked them to think about this at the end of the second interview for discussion during the third interview. Many students really were serious about what would make a better learning environment and were anxious to share their ideas.

The three interviews were scheduled at each participant's convenience, but Seidman (1998) advised that the interviews should take place from 3 days to 1 week apart. If the interviews are too far apart, the continuity of the story is lost; if they are too close together, there is no time to reflect about what has been said. We met in vacant study rooms or classrooms in different buildings on campus, we met under trees on benches, and we met in the library.

The tapes were transcribed word for word using a Dictaphone. I wanted to do all of the transcribing personally because I learned more about the story each participant was sharing by listening again to his or her hesitations, inflections, and speed of speech. Doing this, however, would have created too much time between the actual interviews. For the tapes that I did not personally transcribe, I instructed the transcriber to carefully note all laughter, drama, and hesitations. Therefore, I feel confident that I was able to understand the subtle meanings the students related to their experiences. I also reviewed my written notes taken during the interviews, which added to the transcript information. Each of the transcriptions, my written notes, and any other documentation were placed in a folder and were labeled with the alias that had been chosen for that student.

After the interviews were transcribed and reread, the process of finding themes or common topics began. I separated the parts of all the interviews that addressed a common theme by devising a coding system easily marked on the paper copies of the interviews. These themes or issues came from the passages and were not listed before I began reading. I did not have any idea what the themes were going to be, but patterns or connections became evident as I continued reading the interviews (Seidman, 1998).

What meaning can be found from these interviews and transformed into teaching strategies that should be implemented in science and math classrooms? What common threads or connections exist among these successful students of color and female students

that could help other students of color and women succeed in science and math? It is important to apply data gathered to the real world of science and math classrooms.

Classroom Observations

In addition to the in-depth interviews, classrooms were observed, a focus group was held, and high school and college documents were studied to obtain information about each student. Classroom observations included shadowing the interviewed students in the science and math college classes several times. I saw what was happening in the classes and noted the interactions between instructors and students and between students and students.

High School and College Transcripts

High school and college transcripts were analyzed to determine each student's preparation for a science major. Too many times, students of color are discouraged from continuing in college (much less majoring in science or engineering), so many do not follow rigorous academic programs in high school. It was informative to examine the transcripts of the interviewed Hispanic students who were successfully majoring in science or engineering.

Focus Group

A focus group was also incorporated in the study after all interviews had been completed. Several of the interviewed students met and talked together about their educational journeys. In the focus group, students responded to one another, and sometimes, another student's story sparked a memory that had not emerged in the in-depth, 90-minute interviews (Krueger, 1994).

By examining data collected from all sources, the reason or reasons that each student remained in the science or math pipeline, despite barriers and obstacles, were documented (Seidman, 1998).

RESULTS

As the students shared their experiences, emotions emerged ranging from happiness to sadness at different points along the journey. The interviewer and interviewee became collaborators in determining what had happened to help direct the student to a particular branch of the educational journey. This empowered the student to become an integral part of the research process. Together, coherent and reasonable worlds of meaning were made of the students' life experiences. An intense commitment to the interview process by the students became evident because the students had seldom been asked by anyone about their educational journeys before participating in this study. All had simply traveled the path without reflecting or asking why. As the interviews progressed, students were eager to share, interpret, explain, and understand what had led them to this point.

The data collected from the interviews, classroom observations, documents, and focus group supported the seven themes that emerged and were the guiding factors in helping these 22 Hispanic students choose the educational route that included majoring in science or engineering.

Theme One: Familial Support

All of the 22 students had support systems at home that enhanced their development and consequently enhanced their educational journeys. A study by Alva (1991) specifically dealt with academic vulnerability among Mexican American students and the importance of support resources. Feeling socially supported by a family at home seems to increase students' academic adaptability and encourages positive educational outcomes, as shown by the participants in this study.

Six of the students (Anna, Celine, Cleofita, Maria, Trinidad, and Eduardo) started their journeys from single-parent, low-income family homes. These two "at-risk" factors were red flags that these students would probably have a harder time succeeding in school. One factor that I believe lessened the impact of the at-risk factors is that all of the students had very supportive mothers who were involved in their day-to-day lives. Also, everyone, except Eduardo, had extended families (grandparents) who played big parts in their lives. In today's society, more and more grandparents are taking an active role in their grandchildrens' lives (Reyes, Scribner, & Scribner, 1999). In the lives of these six minority students, grandparents' guidance has helped map their educational journeys. Their importance in the students' lives cannot be underestimated.

> After school, everyday, I went home to my grandparents' house. I did my homework everyday. . . . My grandparents were always a part of my life. They are very proud of me. (Maria)

> My grandfather did not graduate from college, but he is so smart, even today a senior in engineering and if I had a math problem that I was stuck on; I could take it to my Granddad, and if I gave him the book to look through, he would figure it out. He is amazing. (Anna)

> I stayed with my grandparents for entire summers and I remember my grandfather helping me with math . . . math and science, science and math. . . . Um . . . always pushing math and science. They made sure that I was busy with Sports Camp and other programs. . . . They wanted me to be successful and math and science was the ticket, I guess. Also, I was good at it. They are so important in my life. I am living with them right now while I am going to school. They love me and I love them so much. (Celine)

> Since my Dad died when I was young, my entire family is very important to me. We never had money, but my brothers and grandparents made sure that I was good (pause) good in school, good with friends, home when I should be. (Cleofita)

> I am staying with my grandmother this summer. She is wonderful and she cares so much about what I am doing. She encourages me when I get tired of school. She always says that I can do it and she wants to see me graduate from medical school . . . [pause] You know, she will. (Trinidad)

Several of the students from the single-parent families admitted that their mothers had simply dedicated their lives to helping them become the young adults who they were at the time. A study by Smith and Hausafus (1998) interviewed the mothers of 80 eighth grade ethnic minority students and found that a mother's attitude toward science and mathematics and her involvement in the education of her child have a major impact on the success of that child in school.

> I am so proud of my Mom. She is postmaster in our small town. It has always been just me and my Mom. She cares for me. . . . I will always take care of her. I will be a engineer to make money to help my Mom. She always helped me. (Eduardo)

> My Mom dedicated her life to me and wanted to teach her daughter, you know me, that I needed that. You need a good education. You never know what is going to happen in life and you need to be able to support yourself. . . . She wanted me to have a nice life, and I have. My grandparents have been a part of it, I have said that before. . . . My mom knows everything; I can talk to her. (Celine)

> My Mom wanted to make sure that I did not end up like her, pregnant. She has dedicated her life to making sure that I don't make the same mistake. Pregnancies in my town are such a problem for the Hispanic females . . . [pause] it doesn't seem to matter. . . . You know, my Mom never got married. She spent all her time with me. She is my best friend. We met a lot of weekends in Albuquerque, so we can see each other. (Maria)

> My Mom wanted to make sure that I did not end up pregnant like she did. She never got married and spent her time doing for me. She is proud of me and I would not let her down. (Anna)

Students with both parents at home were also influenced by their home environments. These students knew that their families expected a certain level of success in school. Many of the parents did not push the children but simply encouraged them to do well. If there are gaps between the norms and expectations of home and school, these disjunctures can lead to an interruption in a student's journey or taking a different track (e.g., vocational; Darling-Hammond, 1997). These parents were supportive of the school structure and attended as many of the school events as possible, which helped narrow the gap between home and school. The participants in this study had parents who knew what was happening in the schools. These parents were intent on making sure that the programs offered at the schools meshed with their norms and expectations.

> My parents did not push me, I just knew what they expected. My town was small, they knew what was happening in the schools. (Juan)

> My Mom always went to the schools every summer and made sure that I was assigned to the "good" teachers. . . . This teacher was new and could not control the class. My Mom came and talked with the school and I changed classes (Margarita).

> My parents came to all of the school things. (Jorge)

> My parents never missed the school events. I was in a lot of sports, too. I could count on them always. (Deolinda)

All the participants in this study always knew that they had someone to talk with when they came home. All students had help with their homework from parents, grandparents, or siblings. Simply by being interested in students' schoolwork, their families communicated the importance of their educational journeys. By being active listeners, the family becomes one of the major sources of support that is related to a positive school outcome (Rosenfeld et al., 1998). These students mentioned talking with family members many times.

> My brothers were always there for me. I talked with them all of the time. (Cleofita)

> My brother is my best friend. I am planning to help him through college when I finish. He is just taking one class at a time and working full-time with a family. I want to help him. (Miguel)

> I always talk with my Mom. She has helped me decide on my major. I almost went into English and Spanish, but we talked and talked . . . [pause] really she just listened and said a little. (Amelia)

It is well documented that a family's income and the number of years of education attained by the parents influence whether a student will graduate from high school and attend college (Romo & Falbo, 1996). Viewing the data gathered from the interviews, all the parents of these students did attain a high school graduation minimum. Out of the 22 students, 6 had one parent who had graduated from college, and 3 had both parents who had graduated from college. Only 12 students had parents who had graduated from high school only, and 2 students had one parent who had completed 1 to 2 years of college.

It is interesting to note that all of the 22 successful students are bilingual. Some are not quite as fluent in Spanish as they would like to be, but all students mentioned a pride in speaking both languages. Soto (1997) and Valdes (1996) documented the importance of families raising their children in a bilingual environment. Such successful families devise strategies to ensure that the children learn both languages. Hand in hand with this is the family's time spent fostering a pride in their culture's traditions through various means. For example, Celine's mother enrolled her in a Ballet Folklorico group, and Celine still fondly remembered these performances. She brought photographs of herself in her beautiful dresses for me to see. Antonio's family and Juan's family continued many Spanish traditions on the family ranches. Both students were very connected to their families through the land. Fostering this cultural pride and continuing the mastering of two languages have contributed to the success of these students and have enhanced their educational journey.

Families are important in the lives of all students. These 22 students were fortunate to be born into families that believe in education, tradition, and the future. As Eugene Garcia (1999) stated,

> Moreover, "successful" families support and nurture an appreciation of education for all family members. A micro learning community flourishes in the home, with parents teaching children, children sometimes teaching parents, and siblings and extended family members teaching one another. There is an overarching respect for each person's potential and actual contribution to the family. (p. 135)

Talking with these students, I saw the love and connection that they have with their families. This connection only strengthens and maintains their desires to succeed in college.

Theme Two: Honors Program

Remembering that the 22 students were randomly selected with only two things in common (each student was Hispanic and majoring in science or engineering), it was

remarkable to note that 19 out of the 22 students had been placed in an honors program. Almost all the students had been tracked or grouped along with other students with similar capabilities.

The placement of students in an honors program is a form of tracking, and this topic has generated an intense debate for over 70 years. More than 700 studies examining both sides of this debate have not succeeded in quelling the controversy (Loveless, 1999). John Dewey (1938) would not have approved of this ability grouping either, because he felt that education is fundamentally a social experience, not a discrete and isolated academic one. Dewey felt that the interaction between students and teachers to build a community group is very important. To isolate all the "smart" students would be contrary to all desires that Dewey envisioned for students in a democratic society. He would never have advocated a policy that traditionally gives an advantage to the advantaged and a disadvantage to the disadvantaged (Simpson, 1999). *Disadvantaged* refers to the socioeconomic class of students, the educational levels of their parents and close relatives, or their proficiency with the English language (Reyes et al., 1999). Many of my students were from the disadvantaged group, but by being in an honors program, they quickly benefited and became members of the advantaged group. Students placed in the lower tracks achieve less than students of similar aptitude who are placed in academic programs or untracked classes (Darling-Hammond, 1997). Without being tracked in honors programs, it is debatable whether they would still be at this station of the journey. The students I interviewed continued their college education in challenging and demanding majors. All 19 students agreed that they received more attention just because they were a part of the honors programs at their schools.

> We were labeled the brains and we were in everything. Teachers even liked us because we were together. We were always together and helped each other before school. (Josefina)

> In the cafeteria we were together. The teachers always helped us and seemed glad to see us. (Cleofita)

> We got the best teacher and we learned the most. We got to choose what we studied, other kids didn't. (Elorina)

> I liked being smart. I got the good classes. (Roberto)

Advocates against tracking have shown that in numerous studies, the students seemed to be tracked not by ability but by ethnicity. For example, in the San Jose Unified District in California, White students were consistently overrepresented in the higher track classes, and African American and Hispanic students were consistently underrepresented in these classes (Lockwood & Cleveland, 1998).

> Looking back on that class [elementary and junior high], I was the only Hispanic. (Celine)

> Only one other girl was chosen for the advanced math, and she was not Hispanic, but I did not care. I did not like being singled out. (Margarita)

> In my auto-CAD class, out of eight students I was the only Hispanic, but the class was fun. It did not seem to matter. We all got along, but my friends were out of class. (Hector)

As these quotations demonstrate, many times, students looked back on their journeys and did not see Hispanic students in advanced classes. Only in schools such as the ones Trinidad and Anna attended, with student populations that were predominantly Hispanic (over 90%), did a higher percentage of Hispanic students participate in advanced classes. As Oakes (1992) explained,

> The extraordinarily complex connections between tracking and social stratification play out in two ways. First, schools with predominantly low-income and minority student populations tend to be "bottom heavy." That is they offer smaller academic tracks and larger remedial and vocational programs than do schools serving whiter more affluent student bodies. . . . The second link between tracking and students' races and social class is forged in racially mixed schools through the African-American and Latino students to low-track classes. (p. 13)

Research has shown that if all groups are offered an identical curriculum, there is no appreciable effect on achievement. However, when the curriculum is adjusted to correspond to ability level, it appears that student achievement is boosted, especially for high-ability students receiving accelerated curricula (Nicholson, 1998). Being tracked into these honors classes appears to have been advantageous for the students whom I interviewed.

> He [math teacher] challenged us. He made sure that everything that we did, we understood. We could not leave the class without understanding. Of course, our class was small, and we all cared. (Elorina)

> I did not believe that he taught like a college class until I got to college. He really pushed us and . . . BOY, did we learn! (Trinidad)

> We had projects due and they were very complicated. Each month at least a ten page project had to be completed. I worked so hard, but I learned. (Juan)

> He just like had [pause] discussions that were . . . visually . . . you could like, visualize what was really goin' on. Mr. Cosgrove, ummmm, convinced me and another girl to join physics the next year instead of biology. This class I had to study and it challenged me. I liked it! (Roberto)

This finding concurs with the National Education Longitudinal Study, which started with eighth graders in 1988 and followed these tens of thousands of students through school, recording their academic achievement, courses taken, and attitudes toward school. The students' transcripts were analyzed, and their teachers and parents were interviewed. Three major findings were documented: High-track students learn more than low-track students, race and tracking are only weakly related for African American students, and high- and average-achieving students suffer achievement losses in heterogeneous math classes (Nicholson, 1998).

Being a part of the honors program helped establish the feeling within the interviewed students that they were capable. Researchers are in almost unanimous agreement that students who are grouped by ability in high groups have good self-concepts, higher aspirations, and positive attitudes toward school, whereas students grouped in lower groups have losses of self-esteem, lowered aspirations, and negative attitudes toward school (Nicholson, 1998). The interviewed students expressed how they felt about being in the honors programs:

> [Long pause] I was proud . . . I felt good . . . I was proud. I never did hang out with the [pause] Hispanics. Because I felt different. I was proud to be who I was, and I was to be smart and to get good grades. (Celine)

> Well, obviously they always resented us. "Ah you guys are smart!" they would say. And that was . . . that was pretty much their attitude. "You guys stay over there with your smart group!" . . . We went on trips. I felt smart being in this group. (Elorina)

> I liked being number one in my class. Kids looked up to me and I got special attention from my teacher. I always did my homework because I liked being smart. (Ruben)

How students perceive their own ability will ultimately affect their academic achievement and self-esteem (Nicholson, 1998).

The school system's historical search for the best way of organizing students and curricula has never produced a method immune to criticism. The contemporary decision that tracking is unfair, hinders learning, and distributes learning inequitably is well documented (Romo & Falbo, 1996). For the students I interviewed, the tracking system worked to their advantage, not only because they were offered a challenging and demanding curriculum that prepared them for college but also, more importantly, they gained the confidence to learn. There is an old Midwestern saying: "The prairie would be silent if only the most talented birds sang" (Lockwood & Cleveland, 1998, p. 1). The improper tracking of students can adversely affect a large population of schoolchildren, who become locked into a labeled train car along the journey, so their songs are never heard. All students should have the opportunity to attend classes, as these students have done. However, educators will need to make dramatic changes to improve the current situation in many schools. Luckily, the school systems attended by 19 of these students were chartering new routes, and these students (despite being a minority and although many came from low-income families) were given the opportunity to take the higher track. This track served them well in preparing them for future educational challenges.

From this group of self-selected students, 10 out of 22 had attended private schools somewhere along their educational journeys. Repeatedly, the comments were that the parents of Amelia, Anna, Celine, Brianna, Guillermo, Antonio, and Trinidad wanted their children to be challenged and felt that private schools would do this better by providing enriched and challenging curricula. Studies have shown that parents originally committed to public school switch to private school primarily when they believe that their children's needs cannot be met in the schools that they are attending (Darling-Hammond, 1997). Private schools in some way forged a sense of mission, because academics were stressed with smaller classes. These parents felt that their children would be better educated and more prepared for future studies.

> My Mom wanted me to be challenged; so I went here [private school]. We worked hard and I like it. (Amelia)

> My Mom said that it was worth the money. I learned lot. (Celine)

> They [the teachers] really worked us hard. We had so much work that was due. We signed contracts and I was my group's leader. (Antonio)

Theme Three: Challenging and Interactive Curriculum

Throughout the history of education, we have watched the pendulum swing, with many educational programs along the way being proclaimed the "right" ones. Teachers were encouraged to arrange classrooms differently and instruct students innovatively using various methodologies. The students' interviews indicated that we have not made a lot of progress. Many of the classrooms they described could have been classrooms of the 1950s or 1960s. The students described learning from the book, page by page. Science and math instruction in the primary grades was predominantly traditional. The only redeeming factor was the teacher. If the teacher was a kind and caring individual, the subjects were endurable. The memories of early math were primarily whether they could do the problems, not if they understood the concepts. Not one of the 22 students remembered using any manipulatives in the first 4 years of math. The science curriculum was also dry, with a few bean plants sprouting here and there. The majority of the time was spent with the science book and science vocabulary.

> We signed contracts to read so many chapters of science and do the questions and vocabulary words. This was so long and boring. I hated it. . . . I wonder now why I like science? (Antonio).

> I just remember being bored my entire elementary school. I looked out of the window a lot and got in trouble. (Eduardo)

Fourth grade was the first year when some of the students mentioned a difference in the curriculum.

> This private school had a accelerated program that I liked. I finally saw the point of math; we were solving problems not just out of the book. We did the area of the playground, the parking lot, how much cement to buy. . . . One of my friend's Dad could tell us about cement. . . . It made math worth something. (Amelia)

> Fourth grade science was fun! [Trinidad's eyes lit up!] She made science a part of my world and we understood math, social studies . . . I can't give you specific examples, but this is what I remember. Everyone loved that year. (Trinidad)

> Finally, in 4th grade the teacher would answer my question, "Why?" I never liked math because you just did problems In this grade the teacher told me why I was doing the problems. It finally made sense. You know, I had asked other teachers, "Why?" but they said, "Come back later." I forgot to come back after being told the same thing over and over. (Jaime)

> My only year for experiments in the elementary grades was 4th grade. It was so much fun. We were outside a lot. I never knew that science was all around me. (Roberto)

These students knew intuitively that there was a major difference in science instruction in these fourth grade classes as compared to the science instruction of previous years. They did not use the educational jargon of integration, making connections, or constructing knowledge, but they were describing the processes that made a difference in their learning and their enjoyment of learning.

Nine out of the 22 referred to some nontraditional ways of learning science and math in the fifth and sixth grades.

> In 6th grade, I decided to like math. The "crazy teacher" was very project driven . . . [pause] we worked in groups and were allowed to figure out stuff. I liked it. There was a reason to learn math. (Brianna)

> For science in 6th grade, we flew kites. We learned about altitude this way. I had to work independently with two other male students because we were so far ahead in math. We did page work, but we got to do things like kites too. (Celine)

> Sixth grade we combined math and science and made things. Really it was my introduction to engineering, I think. My teacher was wonderful . . . [pause] we quit going by the book. We did activities and it was fun . . . finally . . . it was fun. (Cleofita)

> Even though my teacher smelled like coffee and cigarettes, I liked her. We did not use the book so much. We had science fairs just for our class . . . other fifth grades were so jealous. You know, my sister was in the other class. We used play dough a lot, we were always busy and I remember learning a lot. (Margarita)

Twelve students described interactive math and science classes. The classes that emphasized a hands-on approach with a connection to the world around the students made an impression on the students.

> The teacher introduced physics into the math class in order to make the numbers have meaning. . . . In science there was dissection at I loved. (Roberto)

> I liked using the equipment in science. . . . You know, the Bunsen burners and stuff. (Miguel)

> Math was fun because the teacher had a way of teaching things that stuck to you. She used poems, and lots of weird ways to teach math. I still remember. (Jorge)

> I understood science because there were labs. I never liked to read the book much. (Hector)

> My science teacher was fun, very strict, but he made us think. He liked to show how cars go and different examples. He made science real. (Trinidad)

Sixteen students described high school classes in which they became very excited. These math or science classes had a profound effect on them and in many cases helped to guide them to their present levels.

> Tenth grade science the teacher was superb. We were like real scientists with field notes, lab notebooks, and discussions. We got to explain our results and talk about them. (Jaime)

> My geometry teacher cared that we all learned . . . anatomy class was great . . . [pause] because again the teacher cared and there were so many activities. Science made sense and it related to stuff I knew. (Margarita)

> Being in the advanced class, we got to vote on what we wanted to learn. We chose physiology and anatomy. Mora is a rural community and he tied science to the things around us like cows. (Elorina)

> I was so nervous about being in AP physics, but the teachers was Fantastic! This is really where I decided to become a engineer. The teacher showed us all about the electrical concepts and let us work with the stuff. He selected me to go with two other boys to UTEP engineering fair. I really enjoyed this. . . . [pause] Without this class I may not have become a engineer. (Anna)

> Finally in 12th grade, I liked science. This teacher let us discuss controversial things like genetics, cloning. Should we clone humans. She was not afraid to let us talk about the science that was really happening in the world. I became hooked on science, it made a real difference, and I knew that if I majored in science I could be involved. [pause] You know, I was thinking about majoring in English and Spanish, but I decided I would much rather be reading science journals. (Amelia)

> When I was asked to join the Auto-CAD class with seven other students I felt good. I was not so dumb anymore. After being in special ed for so long, I doubted myself. I really liked the technology and here I am a senior in engineering technology. If I had not been asked to be in this class, no telling where I would be. (Hector)

The students were impressed with classes in which they were allowed to discuss, explore, investigate, and discover. This constructivist approach to learning aligns itself well with the brain-based research that has developed over the past three decades (Caine & Caine, 1994, 1997; Staver, 1998). This type of instruction involves a highly interactive, group-oriented approach that has been proved successful in many other high-performing Hispanic schools (Reyes et al., 1999).

Another important component of this challenging curriculum is that it related to the world outside the classroom (Beane, 1997; Crawford, 2000; Roberts & Ostman, 1998). Teachers connected subjects to careers and made connections between subjects and real life. Because 13 of the students came from small, rural communities, science was more meaningful for them when it was connected to crops or herds. Teachers who consciously tried to make subjects real for students were remembered. Teachers who simply went by the book made only a boring impression, and this impression was transferred to the subject the educator was teaching.

Discussions were important in the challenging and interactive science curriculum. Students love to discuss controversial issues because they become actively engaged and excited about learning (Roberts & Ostman, 1998). If educators continue to ignore such issues in science education, students may believe that science is irrelevant to the increasingly complex real world. By assisting students to engage social, moral, and political issues, science educators are helping them understand the ambiguity and conflict in the world.

> We were able to talk about cloning and other subjects that made me become interested in science. Science had more meaning. (Amelia)

> My math teacher took the time every Friday to put us in a circle and talk about what was happening in our lives. I really enjoyed these talks. Many times we got into argu-

> ments but no one got too mad. We looked forward to Fridays because most teachers would not do this. We seemed to need this. (Celine)

> We really learned about the body, our body. I finally understood what made my body work. I had never really understood all of the ways it worked. I still remember. The class was still hard, but it was fascinating. (Elorina)

Math, especially, needed to be connected to real formulas and real life to answer the students' question of why we study this subject. When the students saw a connection between math and physics, for example, they remembered the teacher and subject as being interesting and meaningful.

Traditionally, the honors programs or gifted tracks have offered quality curricula whereby students are given opportunities to integrate ideas across fields of study; to think, write, create, develop, and explore their own ideas.

> Research indicates that when students of similar achievement levels are exposed to more and less challenging material, those given the richer curriculum systematically outperform those placed in less challenging environments (Oakes, 1985). Achievement differences among students of different racial and ethnic groups in such areas as mathematics, science, and foreign language are strongly related to differences in course taking. For students who have the opportunity to take similar courses, the achievement score differences by race or ethnicity narrow substantially. (Darling-Hammond, 1997, p. 270)

A study that randomly assigned seventh grade at-risk students to remedial, average, and honors mathematics classes found at the end of the year that the students placed in the honors classes excelled far ahead of the students in the remedial and average classes (Peterson, 1989). The honors track promotes a curriculum that encourages students to construct knowledge while applying concepts to the world around them. This makes learning relevant and meaningful. This challenging curriculum that the interviewees kept describing had an effect on where they were presently. Would they have chosen science, math, or engineering careers without being challenged? The answer is most likely "No." The educational opportunities that were given to these students helped to shape their career decisions.

Theme Four: College Preparation

Being prepared for college is important for success (Romo & Falbo, 1996). If a student has not taken the math and science courses that give them a good foundation, college can be an insurmountable task. In looking at the high school transcripts of the 22 students I interviewed, these students did not fit into the national statistics for science and math classes traditionally taken by Hispanic students. According to these national statistics, 60.4% of Hispanic students have taken geometry, 40.9% have taken algebra II, 15.2% have taken trigonometry, and 6.9 % have taken calculus. Only 1.2% of Hispanics have taken algebra II, geometry, and trigonometry in their high school programs, and 0.9% have taken those three math classes plus calculus in their high school programs (National Science Foundation, 1996). Tables 1 and 2 show what advanced math and science courses these Hispanic students who were majoring in science or engineering had taken before choosing

this major. For math, 20 students had taken trigonometry or precalculus, and 18 students continued and completed calculus courses. For science, 20 students had taken chemistry, and 14 continued with physics. Eight of the female students took advanced science courses such as anatomy, biology II, chemistry II, physiology, and scientific research.

All 19 students in this study mentioned in the interviews that it was beneficial to be in the high- achieving classes. The results of the study coincide with a study by Black (1993) in which high-track students often took eighth grade algebra or high school calculus because of the preparation of the high-track classes. Apparently, the honors program influenced the students' decisions. The effects of labeling extend over long periods of time; many of these students had been in honors programs since elementary school. Students who are confident in their own abilities will try harder and will seek out academic challenges, as these students have done (Romo & Falbo, 1996).

Theme Five: The Caring, Kind Teacher

In listening to the students in this study, I repeatedly heard a connection between learning and the teacher. If the teacher did not seem to care, the student did not care. If the teacher showed an interest in the student and a desire for that student to learn, the student learned. Teachers make a difference and are in a position to guide students down a path to a lifelong love for learning. Acting as a catalyst, the teacher can open the world of science, math, or engineering to the student, as did many of the teachers described by the participants.

The students were quick to label teachers "good" or "bad." When asked the difference, the students readily clicked off a list, so I began keeping track because of the similarities within the lists. All 22 students said that a good teacher helps students, cares about students, challenges students, makes students work, uses a variety of teaching techniques, and really wants the students to learn. If a teacher let them simply do minimal work and, therefore, learning was minimal, he or she was not respected by the students. A teacher can determine whether the student even tries or wants to learn in class. As Celine said,

> A teacher can make or break a child, and I really believe it. I mean I've known people who have had a bad professor in the sciences and have changed their major completely. That is powerful for the teacher.

The students were tied emotionally to their teachers. This happens from preschool to the university and beyond. Students know who really cares about them and understands them. Some of the students' memorable teachers were described as follows:

> I was so shy. I hated to talk in front of the room. I purposefully missed the first spelling work I the spelling bee because I wanted to sit down. My teacher later took me out in the hall and explained how I was shortchanging myself. . . . You know, I have remembered this for so long. That teacher cared. . . . I just didn't understand so when she came back she said, "No, Amelia, you are right" I said, "Well I am sorry." Because I didn't want to seem like I was questioning the teacher. After class, she gave me a note that said "Never be sorry for being right, and definitely never say you are sorry, especially to a man." (Amelia).

> Mr. Cosgrove really knew that I could do science. He wanted me to go right into physics after physical science. I did not have the confidence, but he convinced me. He is the first teacher who said that I was really smart. (Robert)

Table 1. Data of High School Science and Math Courses Taken in High School by 12 Hispanic Female Students

Name	Physical Science	Biology	Chemistry	Physics	Extra Science Courses	Prealgebra	Algebra I	Geometry	Algebra II	Trigonometry/ Precalculus	Calculus
Amelia	Yes	Yes	Yes	No	Anatomy	Yes	Yes	Yes	Yes	Yes	Yes
Anna	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Brianna	Yes	Yes	Yes	Yes	Biology II	Yes	Yes	Yes	Yes	Yes	Yes
Celine	Yes	Yes	Yes	No	Physiology	Yes	Yes	Yes	Yes	Yes	Yes
Cleofita	Yes	Yes	Yes	No	Biology II	Yes	Yes	Yes	Yes	Yes	No
Deolinda	Yes	Yes	Yes	Dropped		Yes	Yes	Yes	Yes	Yes	No
Elise	Yes	Yes	Yes	No		Yes	Yes	Yes	Yes	Yes	No
Elorina	Yes	Yes	Yes	Yes	Anatomy, biology II	Yes	Yes	Yes	Yes	Yes	Yes
Josefina	Yes	Yes	Yes	Yes	Scientific research, chemistry II	Yes	Yes	Yes	Yes	Yes	Yes
Margarita	Yes	Yes	Yes	Yes	Anatomy	Yes	Yes	Yes	Yes	Yes	Yes
Maria	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Trinidad	Yes	Yes	Yes	Yes	Physiology, chemistry II, computer science	Yes	Yes	Yes	Yes	Yes	Yes

Table 2. Data of High School Science and Math Courses Taken by 10 Hispanic Male Students

Name	Physical Science	Biology	Chemistry	Physics	Extra Science Courses	Prealgebra	Algebra I	Geometry	Algebra II	Trigonometry/ Precalculus	Calculus
Antonio	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No
Eduardo	Yes	Yes	Yes	Dropped	No	Yes	Yes	Yes	Yes	Yes	Yes
Guillermo	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Hector	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
Jaime	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Jorge	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Juan	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Miguel	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No
Roberto	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Ruben	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

> There was one teacher who really cared about the environment. He made everyone care and this is something that we really needed in life. This teacher took caring past the definition. (Jaime)

> I would have never done so well without this teacher. He helped me before school and after school. He even took me to the store to buy materials. I won at the science fair because of him. (Jorge)

It is evident these good teachers cared about the students in more ways than just the learning factor. The teachers looked at the students as respected human beings. These teachers knew that there is so much more to education than just within the classroom walls.

There were instances, as Miguel and Amelia described, when the teachers literally ignored them. For example, Miguel was always puzzled why, after his car accident, there was not one teacher who helped him to catch up or really even cared that he was back in school. They simply put him back into remedial math. Amelia made a comment about a teacher who did not even ask her why she got a low grade; she felt that the teacher did not care. This has troubled her for so long. Throughout their educational journeys, most of the 22 students had many more teachers who took the time to care about them. They are at this stage on their educational journeys because of the caring attitudes of the teachers.

Educators should worry about the students who are back in the last rows who never see a teacher care about them. What happens to them? They become drop-out statistics. As Anna said, "So many of my classmates just seem to melt away. The teachers did not ask; I didn't ask. What happened to them?"

These students cared deeply about being the minority in the two fields, science and engineering. They all were honest, many receiving additional help at home and in the schools to achieve what they had to date. They admitted there needed to be changes in the schools so that more Hispanic students could get the help they needed to major in science or engineering.

Each one of the students stated that few of their math and science teachers were Hispanic, except for the students who started their journeys in Mexico. Several stated that it would have helped to be able to converse in Spanish with a teacher.

> It was so neat because in 2nd grade my teacher was Anglo but she could speak Spanish. I really liked that. (Celine)

> All of my teachers were Hispanic, and it really was nice because I am Hispanic. (Roberto)

> I always wondered why my math teachers were all White males. (Maria)

In scholarly terms, the students may have subconsciously been worried that the Anglo teachers might not be understanding of their culture or worldview. Worldview refers to the organization of the mind that allows a person to think and feel predictably. Worldview may be "expressed in cosmology, philosophy, ethics, religious ritual, scientific belief, but it is implicit in the individual's every act" (Lynch, 1998, p. 133). A teacher's worldview may not mesh with the worldview of a student, and this can inhibit a student's understanding of, for example, science. If a teacher is from the same ethnic background as the student, their worldviews usually will integrate. Of course, a "good" teacher will be cog-

nizant of this fact and will strive to bring the academic world and the worldviews of the students together in a common understanding (Barton & Yang, 2000).

Teachers and their expectations of the students have a direct relationship to the tracking system (Boyer & Baptiste, 1996). Because almost all of these students were a part of an honors program, they may have had better teachers. Present studies suggest that the more creative and innovative teachers are in this track. Because teachers prefer to teach high-track students, they are much happier and are ready to help the students. Simply by being tracked, these students were able to get classes with the more highly motivated teachers (Boyer & Baptiste, 1996).

What makes a good teacher? Teaching is a very personal activity that is dependent on human interactions. The teachers described by the students in this study have developed interpersonal (skillful relationships) and intrapersonal (character) knowledge as well as professional knowledge. There must be a balance between an intellectual intelligence and an emotional intelligence to meet the needs of the students in the classroom. Regardless, an overarching goal is student learning. Reading these interviews, it was obvious that the emotional side of the teacher appears to have more of an impact than the intellectual side. How a teacher responds to the individual student can determine if that student will learn about science or math or not.

> That teacher laughed a lot. He talked with us about life. I really have always associated math with laughter and fun. I never feared it like other students. Maybe this teacher's caring, happy attitude conditioned me. . . . [pause] That is interesting to think about. (Miguel)

In Vivienne Collinson's (1999) article "Redefining Teacher Excellence," there is a discussion that could have been written by these interviewed students. Students are the clients in this educational enterprise; they are the ones with the tickets for the journey. Educators need to ask them more often about what helps them to learn. As I have found through the interviews, emotions play a role in determining a student's educational journey. Teachers are always the key.

Theme Six: Small Class Size

Out of 22 students, 20 commented many times about the small classes they attended. Some of the advanced math courses ranged from only 1, as with Elorina and Maria's instruction, to not more than 25 students in the large classes. The interviewed students have felt that this made a difference in the instruction that they received.

> So we got to calculus, there was only about nine students. Nine or 10 were left. Yeah. And you know, people didn't start in, in algebra, they had to start algebra in 9th grade. So they could never catch up with us. We got so much attention! I loved it! (Maria).

> The honors physical science was a lot of discussions. There were only 15 of us in this class. I liked it. When I went on with physics, the class was smaller; so we had so much time to do a lot of activities. (Roberto)

> I was the only female in my honors physics class. The AP classes were not very full. I liked it because we knew each other so well and the teacher liked to teach this class. (Anna)

> In the honors science classes there were not very many students. The class was taught like a college class and we learned so much. It would not have worked with a regular class. (Elorina)

Class size research became a very popular topic as the baby boomers entered school. During this period, the researchers and the public wanted to know whether increasing class size interfered with student achievement. In 1978, Glass and Smith identified 77 studies containing 725 different comparisons of pupil achievement in classes of at least two different sizes (Mitchell & Beach, 1990). They found that achievement dropped off sharply when additional students were added to small classes. This finding was reinforced with the Student Teacher Achievement Ratio (STAR) Project that the Tennessee legislature funded for 4 years (1983 to 1987). The basic STAR results stated the following (Achilles, 1992):

1. Small classes benefit all students, but minority and traditionally hard-to-teach students receive approximately twice the benefit from the same investment and treatment;
2. small classes benefit students, teachers, parents; they improve instruction and provide a basis for systemic change in education; and
3. unlike in focused projects, students in small classes achieve better on all measures, rather than just in reading, math, or whatever the focused project is about.

In 1986, Robinson and Wittebois published a review of more than 100 relevant research studies (discussed in Illig, 1998). They concluded that the positive effects of small classes are very promising for disadvantaged and minority students. In the 1990s, data were collected from over 800 school districts in Texas. These showed significant relationships among teacher quality, class size, and student achievement. This achievement fell as the student/teacher ratio increased above an 18:1 ratio (Illig, 1998). There are other studies, but I feel that the data collected from these 22 minority students add credibility to the hypothesis that small classes do make a difference, especially for minority students. These students have proved that they are succeeding in fields that notoriously have been barricaded from minority students.

The small classes added to the learning that these students gained on their individual educational journeys. They were able to talk with the teacher and ask questions.

> The teachers seem to care and talked with us a lot. We knew each other since we were the "Borden Gang." The teacher took a special interest in us and helped us research colleges to attend. This helped me more than anything else to prepare for college. I did not know what to do. (Josefina)

> The Auto-CAD class was super. Only eight students, I was asked to join that class, so the teacher really liked us. He helped me by with me about how I could use this stuff for a job. (Hector)

> The teacher talked to me about horses. She did not have to do this, but she did. Our class was small; so she seemed to make it a point talk with different kids about their interest area. I remember that she brought in a horse picture. I have such a warm feeling about 2nd grade just because the teacher talked to me about something besides spelling. (Celine)

> My math classes only had eight or nine. We really could ask a lot of questions. (Maria)

> In my advanced math, it was just me and another girl. I felt smart, but did not like being singled out really. I did get a lot of attention. You know, I have always been good in math. . . . I was singled out in 2nd grade. (Margarita)

Because most of these smaller classes were attended by students with high capabilities, the teachers adjusted their teaching strategies to challenge these very bright students. If these students are immersed in large classes with many students of varying abilities, the teacher many times will adjust the teaching strategies to reach the middle-of-the-road student or the least able students in the class (Mitchell & Beach, 1990). By being in small classes, these students were involved in a more innovative curriculum that was discussed as another major theme (Achilles, 1992).

In these small classes, the students had their questions answered, and they could not melt into the woodwork. With a small number of students, a teacher is very aware of which students are actively involved in the activities. Small classes make a difference for these students.

Theme Seven: Small Communities

Out of the 22 students, 13 commented on the benefits of belonging to a small community. For example, as Josefina shared,

> Like, when people talk about stuff like that [Columbine incident] like growing up there [Taos] they treated everyone equal. And so when people you I think it's like bunch of bogus, it's just the way they were raised or where they went to school, that's why they have views that way. And they are so one minded. You know it is where you go school. Our community is an equal place, everyone is equal. The community makes the difference. We even wore black trench coats, the honors kids, and there were no problems. The community taught us to accept all people.

Small-town schools have natural connections to their communities. In a small town, everyone knows where the school is, and most people have a connection to the school, even if they do not have children. In these towns, there usually is an unusual commitment to place and belonging that is not found in big cities. It is easy to know where the school is and who the teachers are.

> It was so easy, I could just run across the street. I went before school all of the time for the Science Club. No problem. (Roberto)

This recognition of the importance of the community spirit actually has the label of "communitarianism," inspired by Anatol Etzioni, which connects people to their communities and to one another. An advantage to small towns is that they have this already; they have the basic human connections between their schools and the community (Bellah, 1991). This connection benefits all community members, including students of all ages.

The students felt that the teachers were involved in more decision making, had little turnover, a high commitment, and many years of experience. Also, the teachers cared very

deeply about student progress. Several research studies have had similar findings (Cuban, 1990; Elmore, 1990; Schmuck, 1990). Many of the interviewed students had older siblings who had talked enthusiastically about certain teachers, and the younger siblings (students) were looking forward to being in those classes. Because the teachers stayed in the district, there was a continuity that seemed to make a difference to the students from the smaller communities. The curriculum varied, and students such as Elorina raved about choosing the science curriculum in their high schools.

> I was the baby of the family. I knew the teachers to get and I looked forward to being in her class! Everyone did. (Elorina)

> My brothers told me about the classes and the teachers. I still did not like school and skipped a lot, but at least I knew which teachers to skip! The good ones, I stayed most of the time, but not all of the time. (Eduardo)

> My math teacher really cared if I learned. She still keeps contact with me, because she is proud that I am an engineering major. I remember that in high school; she was hard, but she worked, so we worked. (Brianna)

> I never knew that we really were getting college like courses in high school. This teacher, my science teacher, said that he wanted us to be ready. He cared; he worked hard; our class worked hard. Sometimes we got tired . . . [pause] I really did not appreciate him until I got to college. He was right, I was ready because of him. (Elorina)

The students in this group who were from small towns did exhibit gratitude to the commitment of their schools. They felt that they truly benefited because of the time and energy that were given to them to successfully continue their educational journeys. Because their journeys had stages in small communities, the students were able to take advantage of the opportunities that were offered. The public, at times, feels that larger towns would have magnet schools and more opportunities for students to succeed. In other words, bigger is better. This was not the case for these interviewed successful students in this study. Schools in larger towns might not have given such good personalized service as the schools in the smaller communities. For these 13 students, having the origins of their journeys in small communities helped guide their educational journeys to their successful stages in 1999.

CONCLUSION

Educational leaders must create artful ways to reweave organizational tapestries from old traditions, current realities, and future vision. This work cannot be done by clinging to old ways, emulating principles from effective schools and excellent companies, or divining futuristic images from what we imagine the next decades will be like. Rather, it takes a collective look backward, inward, and ahead. It is a process of transformation. (Lieberman & Miller, 1999, p. 39)

Changing the old ways of educating students will take time. It is a process of transformation, because the stages along the journey must be transformed to emulate the descriptions that these 22 students have shared. Still traveling on their educational jour-

neys, these students know now what should have happened in the past that would have oiled the tracks. Walking into some of today's science classrooms, an observer might think that it is only the 1950s because some schools do not have a vision or a willingness to change. Before the advent of block scheduling, high schools were functioning as they did a hundred years ago: desks in rows, the memorization of facts, few girls in advanced science classes, few minority students in advanced science classes, disconnected science curricula, numerous lectures, and little group work. Will students of color finally give up? Will these science classrooms be places where only White students are encouraged to continue? This option cannot be allowed to occur, because of the loss in human potential. Education, especially science education, can and will be transformed by listening to the stories of these 22 Hispanic students.

The success of science and math education will be measured in terms of student achievement, male and female, Hispanic, and all other minorities. Science and math education must emphasize that science and math is for all students by (a) acknowledging a science curriculum that reflects connections with the students' environments, (b) providing awareness of careers in science and engineering (so that more students take the required courses), (c) educating teachers in the ability to recognize all students in science classrooms, (d) encouraging familial support and providing smaller classes, and (e) providing special programs in which science and math are emphasized for all students. Working together, the vision of the members of the community, schools, and families will be to transform the schools into places where all feel comfortable in science and math classes.

It is distressing to think that without the honors programs; small classes; challenging curricula; caring, kind, and knowledgeable teachers; and superior college preparation, many minority students never have a chance to major in these fields. Schools must be developed in which all students have more of these opportunities, which could better prepare them to choose these majors. There are so many minority students who do not have families at home who encourage them to succeed in school or teachers who really make them feel they have much to contribute. Educators must take note of these themes because they made a lasting difference in these students' lives and futures. Changes must be made in the learning environments of all children if we want to see more minority students, male and female, choose a science or engineering career.

The voices of these 22 Hispanic students who had the courage to reflect and share their educational journeys must be noted. Statistics can be changed! More Hispanic students, male and female, will major in science or engineering, if we as educators have the courage, perseverance, dedication, and insight to transform our science classrooms. We want more Hispanic students to choose the science or engineering route on their educational journeys, but most of all, we want them to know that the opportunity exists for them because they are respected members of the community.

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