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Veronica Vijil
Canutillo ISD

Julie P. Combs
Sam Houston State University

Rebecca M. Bustamante
Sam Houston State University

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Barriers to Pursuing STEM-Related Careers: Perceptions of Hispanic Girls Enrolled in Advanced High School STEM Courses

Veronica Vijil, Ed.D.¹
Canutillo ISD

Julie P. Combs, Ed.D.
Sam Houston State University

Rebecca M. Bustamante, Ph.D.
Sam Houston State University

Researchers indicate that the United States has fallen behind other nations in science, technology, engineering, and mathematics (STEM) education (President’s Council of Advisors on Science and Technology, 2010, 2012). A declining interest in the field of engineering as demonstrated by students who pursue degrees in STEM fields also threatens the U.S. competitive edge (National Science Foundation, 2013; Schneider, Judy, & Mazuca, 2012). Although some students perform successfully in STEM courses, an achievement gap between school-aged boys and girls is well-documented in the literature (e.g., College Board, 2007). Moreover, Hispanic students are underrepresented in science-related courses and careers (Hanley & Noblit, 2009) and even fewer Hispanic girls are attracted to the STEM areas despite the increase in the Hispanic population in general and in higher education (Dolan, 2009). In fact, few studies were located that addressed perspectives of Hispanic girls about their experiences and perceptions related to science and engineering (Crisp, Nora, & Taggart, 2009; Moller et al., 2015; O’Shea, Heilbronner, & Reis, 2010). Specifically, there is a need to attract girls and Hispanic students to mathematics and science coursework and careers. Therefore, the purpose of this collective case study was to explore and identify potential barriers and supports related to select Hispanic high school girls’ decisions to pursue advanced coursework and future careers in STEM. By increasing awareness of these potential barriers, school leaders will be better positioned to develop strategies and support systems to encourage Hispanic girls to take advanced science courses and seek out postsecondary studies and careers in STEM fields.

Literature Review

Despite the large numbers of Hispanics living in the United States and the extent to which they value education, Hispanic students continue to face significant barriers to their academic success and lag behind their peers academically (Dolan, 2009; Nichols, Glass, & Berliner, 2012). Among the barriers are high dropout rates, low graduation rates, and lower reading and mathematics scores. Further, socioeconomic status, parental education, school quality, and immigrant status predicted the performance levels of Hispanic students (Desmond & Turley, 2009). Researchers have noted several interventions that have supported Hispanic students in their educational efforts (e.g., Moller et al., 2015; Secada et al., 1998). Promoting a sense of

¹ Veronica Vijil may be reached at v.vijil64@gmail.com
belonging among Hispanic students and a shared emotional connection with the school were key findings related to higher Hispanic student performance (Sanchez, Colon, & Esparza, 2005). Further, Hispanic students were more likely to study STEM in college “when they were educated in high schools... with engaged and satisfied teachers who worked in collaborative professional communities” (Moller et al., 2015, p. 21).

Another area explored by researchers to account for Hispanic underachievement involves the influence of the family and is termed *familism*, a social pattern especially prominent in the Hispanic culture and may be observed through dispositions, values, and beliefs that the family deems most important (Desmond & Turley, 2009). Major decisions are made in respect to how these decisions will affect family bonds, often deferring to the family matriarch or patriarch (Desmond & Turley, 2009). For example, one trend noted among Hispanic high school seniors in Texas was the desire to select a college close to home (Desmond & Turley, 2009), an outcome often related to parental expectations (Raffaelli & Ontai, 2004). In some Hispanic families, children are expected to fulfill traditional gender roles. That is, women are expected to raise families and place as priority (Raffaelli & Ontai, 2004). Latino parents reported treating boys and girls differently and discouraged girls from seeking jobs or participating in outside activities (Raffaelli & Ontai, 2004). Young women were more likely than men to have more limits placed on them (Raffaelli & Ontai, 2004). As such, differences in gender-related socialization might account for the interest pursuing a career other than engineering.

**Gender Discrepancies in STEM**

The need to increase the number of women in STEM professions has been a recurring theme in the literature for a few decades (AAUW, 1992, 2010). Steady increases in enrollment have been evident in the number of women within specific science areas such as medical schools and graduate programs in biology; however, areas such as mathematics, engineering, and physics continue to show an underrepresentation of women (Xu, 2013). In spite of young women successfully completing advanced courses in mathematics and science in high school, women have represented only a small percentage in the STEM workforce (Hoh, 2009; Ullman, 2010). Furthermore, the majority of engineering positions continue to be filled by men, and women continue to experience a disparity in their salary compared to men (National Science Foundation, 2013).

Researchers such as DeCohen and Deterding (2009) have explored possible reasons for the underrepresentation of women in engineering. The researchers noted that the attrition level for both men and women was similar. Contrary to previous beliefs, results suggested that gender disparities in engineering were driven largely by the inadequate enrollment (not adequate retention) of women. They concluded that the underrepresentation was due more, in part, to recruitment rather than retention, and, therefore, outreach to women should be implemented across institutions at all grade levels including the collegiate level (DeCohen & Deterding, 2009).

Researchers reported that a gap in STEM interest exists by the eighth grade where boys were twice as likely to prefer a STEM career (AAUW, 2010). Some researchers have studied the career goals and course-taking trajectories of high school girls. Girls who had indicated an
interest in majoring in STEM did not enroll in the highest level of science and mathematics courses available to them in high school and lacked preparedness at the collegiate level (Tyson et al., 2007). VanLeuvan (2004) studied the changes in career goals of 66 students and reported girls' interests in STEM careers decreased from Grade 7 to Grade 12. Researchers have identified several factors that influence STEM interest among Hispanic students as follows: participation in advanced math and science courses, math achievement, a rigorous curriculum, and teacher support (Arredondo & Castillo, 2011; Crisp et al., 2009). Therefore, attitude and a lack of confidence could be identified as contributors to an underrepresentation in STEM fields in addition to math and science achievement levels.

Method

Collective case study method (Stake, 2005) was utilized to explore the experiences of a select group of Hispanic high school girls. The case study was bounded (Merriam, 2001) by the fact that only the experiences of high school Hispanic girls who had chosen engineering as their career pathway were considered within one school district. Two research questions were posed in the study:

1. What are the perceived barriers among high school Hispanic girls in relation to taking advanced science and mathematics coursework?
2. What are the support systems identified by Hispanic girls enrolled in high school engineering courses?

Context of the Study

Participants were selected from four suburban high schools in a southeastern U.S. public school district; three were comprehensive high schools and one was a high school career academy where students completed courses aligned with career interests. The district was selected based on (a) its offerings of STEM coursework, (b) its data about students' career pathways, and (c) its ethnically diverse student population. As part of a state initiative, the district offered a career pathway program that comprised a recommended sequence of coursework based on students' career goals. Engineering represented one pathway within the 16 career clusters offered in this school district.

Selection of Participants

A purposeful criterion sampling scheme was used to identify the participants (Miles & Huberman, 1994). The four criteria were: female, Hispanic, enrolled in Grade 11 or 12, and selection of STEM as a career pathway. Transcripts were reviewed for all Grade 11 and 12 students (208 male and 28 female students) who had chosen engineering as a career pathway. Only nine Hispanic girls met the criteria and all were invited to participate in the study with approval from the school district, the girls' parents, and the girls themselves. Seven girls agreed to participate.

Instruments

A multi-method, three-stage data collection approach (Yin, 2009) was taken to explore the support systems, prior experiences, and perceived barriers that encouraged these Hispanic girls to pursue the STEM career pathway in engineering.
Phase 1: Demographic Data Questionnaire. Participants were asked to complete a short demographic questionnaire. Questions included background information, average grades attained in middle school and high school science and math courses, highest level of attained in these courses, and intentions to pursue engineering as a college major.

Phase 2: Focus Group Protocol. Two focus groups were conducted. The interview protocol was grounded in the literature review and Spradley's (1979) interview approach of descriptive, mini-tour, and experience questions.

Phase 3: Individual Interviews. All seven of the participants agreed to individual interviews. Questions were open-ended and allowed for triangulation of data collected during Phase 2. Questions allowed participants to recall and describe specific experiences, support systems, and perceived barriers.

Data Analysis
Using the method of constant comparison (Glaser & Strauss, 1967), an iterative coding process was applied to analyze interview data and interpret common themes and subthemes across the cases. Specifically, the process of open coding and then axial coding were carried out (Strauss & Corbin, 1990). Finally, selective coding was used by merging the previous analytical work and identifying core categories that related to each other (Strauss & Corbin, 1990). Additionally, a cross-case analysis was conducted using a “partially ordered meta-matrix” (Miles & Huberman, 1994, p. 177). A partially ordered meta-matrix allowed the researcher to display data from several cases into a format. Clusters or partitions were contrasted between sets of cases to reveal a clear picture (Miles & Huberman, 1994).

Findings
Based on an analysis of the interview transcripts, two types of barriers were identified: existing and perceived. Existing barriers were actual barriers the girls reported experiencing such as gender discrimination, complex concepts, and ineffective teachers whereas perceived barriers related to those the high school girls predicted for the future such as gender discrimination, limited college funding, and work-life balance. An overview of the barrier themes and subthemes are shown in Table 1. In addition, three support themes were derived in response to these barriers: an attitude of perseverance, teacher relationships, and family support.

Existing Barriers: Gender Discrimination
One barrier that was associated with taking advanced science and mathematics courses related to being girls. Participants agreed that although they were comfortable working in groups comprised of mostly boys who frequently interjected derogatory comments. Beatriz described her experience: “Sometimes, yeah, there’s sometimes that they [boys] try to put me down, some of them [boys], and then there are some guys that don’t like me.” Participants reported they remained focused on their coursework despite negative comments.

Boys outnumbered the girls in engineering elective classes in both high schools; however, this imbalance was not evident in science and mathematics classes. Being one of a few girls in a class, Daniela explained how she used her strengths to excel in those classes:

I’d say I’m more mature. In a class of 30 and probably, and, uh, maybe I’d say what a 4th or 5th of them being girls, um, you kind of realize how the guys act and . . . tend to be
a little more scattered in their thoughts, and being a girl, it makes it a little easier to bring all of that together.

Clearly, some boys in the advanced science and mathematics classes appeared to contribute to the stereotypical beliefs that can place girls at a disadvantage in the engineering field.

Table 1

| Barrier Themes for Hispanic High School Girls Enrolled in Engineering Courses |
|-------------------------------|---------------------------------------------|
| Theme                        | Sub theme                                    | Meaning                                                                 |
| Existing Barriers            | Gender Discrimination                        | Obstacles experienced with peers and adults related to being a female in a male-dominated career path |
|                               | Complex Concepts                             | Obstacles experienced with taking high school courses in math, science, and engineering |
|                               | Ineffective Teachers                         | Obstacles experienced with teachers and learning                         |
| Perceived Barriers           | Gender Discrimination                        | Obstacles related to being a female in a male-dominated profession (engineering) |
|                               | Limited College Funding                      | Obstacles related to obtaining funds to obtain a college degree          |
|                               | Work-Life Balance                            | Obstacles related to maintaining a balance between a career and the roles of wife and mother |

**Existing Barriers: Complex STEM Concepts**

Another barrier involved the complex concepts taught in the higher-level science and math courses. For example, two mathematical concepts that were most challenging were vectors and derivatives. Gloria said, "The equations [in mathematics class] are just confusing, and I have to really, like, pay attention to what I'm doing." Gloria explained her difficulties with Algebra II by stating, "it's how we go with the exponents and, like, dividing them, or these algebraic expressions, [they are ] just getting harder."

Relevance and meaning were important to the understanding of complex subjects. If the girls did not connect various concepts, they felt resistance to exerting efforts to learn. Therefore, the
participants described how they sought ways to grasp the concepts often by relying only on themselves to learn the material. The girls believed that they could not rely on their parents for assistance with complex concepts and none of the participants mentioned working with a tutor on an individual basis, noting that the added expense of a private tutor was too expensive for their families.

Existing Barriers: Ineffective Teachers
The quality of teaching that took place in STEM-related courses was noted as a barrier. Students recognized the difference between strong and weak teachers and described how some of their teachers seemed “inept”. Gloria recalled a negative experience with a teacher: “Sometimes it depends on the teacher because this year, my Physics teacher, it’s like, here’s the paper and video, and she doesn’t explain what’s going on, so sometimes it’s harder to understand.”

Perceived Barriers: Gender Discrimination
The girls perceived engineering to be a male-dominated field and believed that they would continue to be out-numbered by men. They predicted several career barriers to becoming a woman engineer, such as making less money than men and competing for better paying positions. However, the participants expressed how they were intrinsically motivated to succeed. When asked about the difficulties a woman might encounter on the job as an engineer, Felicia worried about the physical labor involved because she believed carrying heavy equipment would be more difficult for a woman. Gloria expressed, “I guess people would listen more to a guy’s opinion than for a girl.” Overall, the girls acknowledged that hardships existed in other fields besides engineering, and that their pursuit of goals would likely be met with challenges.

Perceived Barriers: Limited College Funding
Another perceived barrier that existed was the cost of postsecondary education. Daniela was proud that she would be the first in her immediate family to attend college but described how she would need to attend a community college. She discussed the funding barrier when she stated:

I think one of the major set-backs for a lot of people, not just people in engineering but for other majors as well. They can’t afford to go [to college], and I mean they say that there are all kinds of money out there, but honestly, I don’t think they’re giving it to the right people.

Perceived Barriers: Future Work/Life Balance
Participants predicted that balancing the demands of an engineering career with the hopes of raising a family would be difficult. For some of the girls, raising a family was their priority. Cristina believed, “an important aspect of family was to be there for every aspect of their [children’s] lives.” She expressed she would either seek a part time job or take time off from work if she decided to raise children and count on her husband to take care of the family’s financial needs.

However, for some of the other girls, the reality of the modern world economy was something they considered for their futures. Alicia mentioned, “I see the job economy going down the toilet.” Daniela recognized that someone would have to replace retirees in the future: “There are going to be highs and lows, but at the same time, they [engineering companies] are always going to need someone to take over for the people who are retiring and that sort of thing.” The
participants understood that staying home to raise a family would create challenges to support a family with only one income.

The participants acknowledged their concern about the balancing of time between career and family. Cristina was very honest about her feelings about raising a family. She stated, “I know for me, I want to start a family and I’m not going to sacrifice my kids’ young years just for a job that my husband can provide for.”

Support Theme: Attitude of Perseverance
The girls in this study described how they adjusted their attitudes to address barriers. In sharing their experiences, the participants exhibited a strong self-efficacy, perseverance, and higher-level thinking skills. They expected to forge ahead, securing opportunities that would allow them to successfully complete engineering courses and compete with their male counterparts. The participants talked about being the trendsetters in a male-dominated world. Rather than feeling defeated in their pursuit of STEM courses and careers, the participants did not dwell on the fact that they were outnumbered by boys in their engineering classes. Christina believed that she had the edge over the boys in her class when she explained what people said to her, “Oh, you’re the only one or two girls in that class; for me, it’s something to feel proud of because you’re in another league.” The participants in the study demonstrated an attitude of resilience and perseverance with the barriers that they perceived or experienced.

Support Theme: Teacher Relationships
Although poor teachers were recognized as an existing barrier for these students, some teachers offered support to the girls. Teachers were deemed as supportive when they developed caring relationships and provided the participants with necessary skills for success. Alicia described some of her middle school science teachers as extremely helpful. She said, “I had fantastic teachers. I felt like we got so much stuff done and I learned a ton.” Alicia recalled a positive experience for two years in elementary school:

- In 4th and 5th, I had the same teacher both years and she was a very, very good teacher. She forced us to participate in national science competitions and all sort of stuff, so I feel like science those years were extremely strong, and I did get a lot out of them.

Alicia felt challenged in middle school especially in her mathematics courses. As a student in the gifted and talented program, her mathematics courses were accelerated so she worked two grade levels ahead of her peers and acquired high school credit beginning in seventh grade. In their recollections, the girls described past teachers in different ways such as “fun,” “overachieving,” “uncaring,” and “boring.” In most cases, the girls remembered their relationships with teachers instead of the actual lessons or activities that supported their decisions to pursue STEM courses in high school.

Support Theme: Family Support
Families were usually described as supportive; however, the amount of support varied among the participants. Five of the seven participants revealed that they had supportive families and indicated that one of their parents had encouraged them to select engineering. For example, Alicia’s mom and Daniela’s dad encouraged them from a young age. Daniela shared that her dad was “extremely happy because neither of my parents actually finished school” but had to convince her mother that engineering was the right decision for her.
Eva was one student who did not view her family as supportive. She stated, “They [family] just think that I just shouldn’t do it at all because of the males in the field, and women aren’t supposed to, you know, be strong and do what men do.” Although they had varying degrees of family support, the participants credited their parents as supporters who could help them achieve future goals. In addition, the participants said that they discussed college and career options with their parents in an effort to keep it at the forefront of their parents’ minds.

Implications for School Leaders

A sense of urgency has been placed on educational institutions to educate students to become proficient in science and mathematics and to encourage students to explore these fields as career options (National Science Foundation, 2013). Even with the increased emphasis in STEM, few Hispanic students pursue postsecondary STEM degrees. The Hispanic girls who participated in this study were the only seven of nine enrolled in the engineering pathway, even though they attended one of four large high schools in a large suburban/urban school district of over 35,000 students. The results of this study provide clues to ways that school leaders might improve efforts to increase the enrollment, persistence, and academic success of Hispanic girls in district STEM programs. School leaders can support these efforts by (a) ensuring quality teachers and teaching in STEM courses, (b) garnering Hispanic family support, and (c) cultivating college readiness that involves developing resilience and positive self-efficacy in Hispanic girls.

Ensuring Quality STEM Teaching

In our study, teachers contributed to both the existing barriers for participants and to the support systems. Two participants received solace from the encouragement of their teachers. For Eva, who otherwise would not have had a strong mentoring support system, one particular teacher with whom she bonded became her source of inspiration. Similarly, teachers of higher-level courses should remain advocates for their students rather than setting up an environment where students feel disconnected to the course. The participants in our study had the ability to perform well in mathematics and science and relied on their own teachings when the teacher was ineffective. However, average students should be encouraged to take these higher-level courses, and teachers should make every effort to understand the concepts that students are expected to learn. School leaders might ensure that students have a voice in expressing their views about teachers, especially in advanced courses. Administrators should address repeated concerns expressed by students. Ensuring teachers purposefully engage students and cultivate curiosity appears essential to sustaining and expanding Hispanic girls’ interest in pursuing STEM studies such as engineering.

Garnering Family Support

Family connections were very important to the participants in our study. When responding to a question about college choice, many stated they did not want to be away from family. These responses coincided with research literature (e.g., Desmond & Turley, 2009). To address this challenge, high school leaders can communicate with families through forums and workshops where college representatives and current college students can provide examples of the kind of student support that is available to students living away from home.
Cultivating College Readiness of Hispanic Students

The themes in this present study that most closely aligned with previous research findings are the description of the high school girls’ existing barriers relating to complex concepts in their coursework and their resulting attitudes of perseverance. The participants in this study cared a great deal about school, were encouraged to attend college, and were successful academically. Similar to the findings of other researchers, these Hispanic girls were most likely to learn when the curricular content was challenging and meaningful to them.

Related to college readiness is the aspect of financial aid. In this study, participants reported financial concerns that could impede their college attendance. Perhaps the families in this student needed more information and guidance with the financial aid process, especially for the girls who were first-generation college students. Advocates are needed to help students enter fields that are underrepresented by women. School district administrators should be willing to schedule bilingual, financial experts to help parents complete financial paperwork. Teachers might consider adding information about the college application process in introductory classes. Providing time for students to explore websites such as those provided by the College Board might serve as a helpful resource.

Conclusions

Researchers have indicated that Hispanic students have the lowest educational aspirations and expectations of all major racial and ethnic groups (Desmond & Turley, 2009). Some stereotypes among U.S. educators suggest that Hispanic students do not care about school, have cultural backgrounds that are incompatible with school, or cannot achieve. Yet, results from this study contradict those stereotypes and offer educational leaders ideas for better supporting successful STEM career pathway pursuits of Hispanic high school girls.

This study was one of few to date that has examined the perceptions of the unique population of high school Hispanic girls who have pursued STEM-related careers in high school. The findings are useful in considering various theories related to student persistence in higher education in general, and mathematics and science-related careers in particular. In addition, the findings can be used intentionally by educational leaders to identify and remove potential barriers for Hispanic girls in relation to STEM courses.

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