Women's Self-Efficacy Perceptions in Mathematics and Science: Investigating USC-MESA Students

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Abstract

Higher education institutions have struggled with the underrepresentation of female students in the STEM majors. The authors investigate the USC-MESA program and the role of women's self-efficacy perceptions in mathematics and science. It is crucial to understand the theory of self-efficacy in examining historically underrepresented populations in the STEM fields and the external factors that play a key role in their persistence to pursue STEM fields in college and beyond.

Since World War II, postsecondary educational institutions in the United States have been challenged with the underrepresentation of women in the mathematics and science fields in higher education. Although female students have enrolled in postsecondary education immediately after high school at higher rates than male students, gender discrepancies still exist among bachelor degree recipients in mathematics and science (National Center for Education Statistics [NCES] 2004). State and federal dollars have been spent to encourage and prepare these underrepresented students to pursue a math-based college major in order to close the gap that presently exists. Have these dollars been successful in increasing the underrepresentation of women in the mathematics and science fields by attracting them to the field, preparing them for college entrance, and encouraging them to see the mathematics and science majors as viable college majors?

We studied women's self-efficacy perception in mathematics and science as the variable in attempting to understand its relationship with regard to college major choice. In particular, we examined female high school seniors who were participants in the University of Southern California (USC) MESA (Mathematics Engineering Science Achievement) precollege program starting with their freshman years in high school. The study focused on gender as it related to self-efficacy in math and science and was driven by two core questions. The first question pertained to the role of women's self-efficacy perceptions in math and science when selecting a college major, and the second question sought to understand components of the MESA program that encourages female students to see STEM majors as a possible academic and career option for them. This study is from an ethnographical perspective in order to observe and understand the behavioral and intellectual processes that occur among these female high school students.

Theoretical Foundation

We reviewed a body of literature focusing on women self-efficacy perceptions in the math and sciences related to their academic pursuits. Prior to examining these theories, we examined precollege programs that focused on increasing access to historically underrepresented students in higher education such as Upward Bound, TRIO, MESA, and USC's Neighborhood Academic Initiative (NAI). Understanding programs that focus on increasing the pipeline between K–12 and higher education provided a fundamental understanding with which to examine research theories that attempt to explain and bridge the gap.

Bandura's (1986) theory on self-efficacy perceptions, stemming from his social cognitive theory, served as the backdrop for the study. According to this theory, self-efficacy perceptions stem from four sources: (1) mastery, (2) vicarious experiences, (3) verbal persuasions, and (4) affect. In academics, self-efficacy beliefs determine the choices that students make, the time and effort they will devote to a task, their persistence toward their goals, and their resiliency when faced with an obstacle. Bandura's theory has been used as a foundation to further understand an individual's academic choices, motivation, and pursuits. In particular, self-efficacy perceptions have been a backdrop in the context of the STEM domains in education. Researchers have made STEM a central focus in studying self-efficacy in academics and career achievement in order to explain the discrepancy between gender representation in these academic and career fields (Bandura et al. 2001; Hackett and Betz 1989; Pajares 1996, 2002; Oakes 1990).

To further examine women's mathematics-related self-efficacy as it relates to educational and career choices, Oakes (1990) examined the external factors of stereotyping in math and science fields as an additional explanation for the disparity in representation. Oakes asserted that societal factors such as parents, school resources, and teachers were influential in shaping the attitudes of minorities and women toward mathematics and science and, in particular, shaping how efficacious individuals will perceive themselves to be in the STEM fields. Lent and his colleagues (1984, 1987, 2003) sought to examine how women's self-efficacy perceptions in STEM fields have narrowed their academic and career goals and how gender stereotypes have posed as a factor. From their research, women who take the nontraditional pursuit of STEM majors and careers must have environmental support and influences to positively shape their self-efficacy perceptions.

Zeldin and Pajares (2002) sought to unearth the impact of self-efficacy perceptions in women who have persisted in the STEM majors and have obtained a career in the field despite societal barriers. Their qualitative approach to examining the phenomenon resulted in two themes. First, vicarious experience and verbal persuasions were integral factors in developing and maintaining self-efficacy beliefs for women in mathematics-related careers. In particular, due to the academic and social obstacles present in male-dominated fields, the need for verbal encouragement and persuasion appear especially important for women. Second, their research supported Bandura's (1986) social cognitive theory that women's self-efficacy perceptions are an important factor in overcoming obstacles in order to achieve their goals. The women in Zeldin and Pajares'

(2002) study reflected on specific incidences and verbal persuasions in their academic careers that motivated them to persist in their goal of majoring in the STEM fields.

These studies implied that the underrepresentation of women in the mathematics and science fields is due to a lack of academic preparation, a lack of positive self-efficacy perception, and cultural stereotypes that have discouraged women in the field. Whether this is true in regards to women's self-efficacy perceptions in math and science and its impact on their college major choices is still ambiguous, especially for individuals who are not part of the dominant society and will be the first in their families to attend college. The process these women experienced at the crossroad where these choices are made are not apparent in the literature. The support of a precollege program whose sole focus is to prepare disadvantaged students for success in school and college, particularly in the mathematics and science fields, has not been examined. The goal of the study brought forth a deeper understanding of how women's self-efficacy perceptions in math and science influence the academic and career decisions they make.

Methodology

To address the research focus, we chose a qualitative approach rather than a quantitative approach. Utilizing a naturalistic, qualitative approach gave us the ability to gather rich and thick descriptions from the subjects as we got to ask the "how" and "what" questions. This type of ethnographic approach gave way to a holistic perspective of these students' realities. To give voice to the research participants, we used four methods from ethnography: (1) in-depth interview, (2) focus group, (3) observation, and (4) document analysis. Examining cultural behaviors through these four methods improves the credibility of the research results (Wolcott 1975).

Twelve female seniors and three female juniors were selected to participate in the study. The participants qualified for the study because they had been active and consistent members of the USC-MESA program on their campuses since their freshman years in high school and would be first generation college-goers. Though the female juniors were not applying to college in the fall, they were able to share their personal experiences with the MESA program and had started to think about their futures. Since they were in the thick of application submission, the students were asked about their college application process, their feelings about going to college, their families and neighborhood, and their perception of the USC-MESA program. Along with the students, we interviewed three USC-MESA advisors and three USC-MESA staff members including the director of the program.

Theoretical Implications

Three conceptual categories surfaced from the findings in our study: (1) personal awareness, (2) connection to environment, and (3) factors that help or hinder. The participants shared their personal stories of how they became involved in the USC-MESA program, their thoughts and feelings about math and science as it relates to their college majors, and factors that have influenced them in their college pursuits.

The outcomes will serve as a guide for policy recommendations and program improvement. The intention is to assist educators, program administrators, and researchers in becoming more aware of women's self-efficacy perceptions in math and science and its impact on their academic and career pursuits.

Personal Awareness

The female senior participants were able to reflect upon their own experiences from childhood and express reasons for why they have participated in the USC-MESA program for the past four years in high school. They were able to judge their own capabilities and support their rationale for their interest in the math and sciences and their desire to pursue the field. Bandura (1986) theorized this judgment of capabilities as one's self-efficacy perception and connected it to how it shapes students' effort and persistence in a task. Self-efficacy perceptions have been argued as stemming from four sources. Bandura (1986, 1997) argued that the most important source comes from the interpretation of one's past performance, which he named mastery experiences. In accordance with the requirements to participate in the USC-MESA program, all the participants are meeting the University of California A-G requirements, which means that they were enrolled in Algebra by the 9th grade and continued into higher level math classes each consecutive year. In addition, all the participants enrolled in advanced levels of science such as biology, chemistry, and physics. The trajectory of the courses taken by these female students and their abilities to persist in them supports Bandura's (1986) assertion that mastery of a task creates a strong sense of efficacy to accomplish a similar task in the future. The evidence that these students have mastered one challenging course after another demonstrates a strong self-efficacy perception in these domains.

Several of these students shared their experiences prior to entering high school that influenced their love for math and science. Participants recounted trips with their parents to Griffith Park Observatory or winning science fairs in school, which left positive emotions regarding the math and science domains. Their preference for the STEM fields cannot be disconnected from these experiences. According to Zeldin and Pajares (2000), students who are exposed to mathematics-related content early on find this domain comfortable and familiar, thus creating a positive self-efficacy perception in the area. This positive self-efficacy perception has contributed to these students' resiliency when faced with obstacles or when tackling an unfamiliar task in the domain.

Pajares (1996) argued individuals with high self-efficacy will experience feelings of serenity in approaching difficult tasks and activities while low self-efficacy beliefs may foster emotions of stress and depression. Students revealed personal stories that spoke of determination, confidence, and resilience. Their struggles in math often were masked by their unwillingness to relent in the face of obstacles. Whereas individuals with low self-efficacy beliefs may feel depression, these students are optimistic in nature, determined to learn from their mistakes, and cleave to an "I'm going to do it" attitude. Often their positive attitude is fueled by a belief that "girls can do it, too" or a sense of "girl power." Internally, they are aware of the stereotypes that surround them. They believe they are capable, despite not seeing "many female scientists or engineers out there," and

hypothesize that other women get "discouraged when they don't see any [female scientists or engineers]." One participant expressed that the way to get more women in the field is to show "females what we do, the hands-on science, the math, and the engineering, and the importance and the usage in this world." This strong self-efficacy perception supports Bandura's (1986) hypothesis that an individual's strong self-efficacy perception in academic domains will create a sense of confidence to pursue further study. From the individual and focus group interviews in conjunction to observations, these students not only set their goals on attending a four-year college or university and breaking stereotypes, but being the first in their families to accomplish this task.

Zimmerman, Bandura, and Martinez-Pons (1992) examined the connection between the role of self-efficacy beliefs in goal setting for academic attainment and found a strong positive correlation. Their quantitative study of high school students found a parallel between students' academic goals and perceived self-efficacy beliefs and suggested that the higher the perceived self-efficacy, the higher the goals student set for themselves. In this study, these female seniors have navigated through some of the most challenging math and science courses in high school. They have continued to set high goals and aspirations for themselves as they apply to universities like USC, UCLA, and UCSD under their pre-med, engineering, and science majors. In conjunction with Maple and Stage's (1991) linear path analysis model, the academic choices made in one's sophomore year of high school, particularly math and science experiences, was a significant predictor of the field of study in college. From a linear model perspective with only academics in consideration, these participants are supporting the theory behind the mathematics and scientific pipeline. However, among their peers and within their neighborhoods, these participants are considered the exception rather than the norm. While Maple and Stages' study (1991) examined internal factors, it did not take into consideration external factors related to one's environment.

Connection to Environment

Participants in this study come from distinct environments that have impacted their lives as well as their futures. From the data collected, the students are aware that people inside and outside their communities refer to their neighborhoods as the "ghetto" or the "hood." Their fears of remaining in this environment affect the choices they make on a daily basis and drive them to connect to a different world that creates a different reality for them. The previous section examined how theories on self-efficacy perceptions and academic achievement explain the personal awareness of the participants and how the role of self-efficacy perceptions in math and science has influenced their academic goals. This section examines participants' connections to their neighborhoods in contrast to the MESA community and what research literature purports on the role of environment on their self-efficacy perceptions. In addition, we will examine how the participants integrate their environments into their academic and career pursuits.

Neighborhood

The female USC-MESA seniors were cognizant of the realities of their lives as residents in their neighborhoods. When discussing the impact their neighborhood community has on their daily lives, the discussions were passionate, and strong emotions were stirred up. They recognize that their communities do not foster a college-going environment and "not many people actually go to college" nor complete high school. In addition, one participant described her neighborhood as unsafe with "many pregnant girls and a whole bunch of high school drop outs." The sociocultural messages that surround these participants in their communities do not communicate messages of hope for their futures nor support their dreams of becoming engineers. One participant shared, "that [messages from the neighborhood] only encourages me to go further and not live up to those standards . . . prove them all wrong." These seniors are determined to find a means to get out of this type of environment and perceive going to college as the only way out. The notion of socialization presents new and revealing information, as it has not appeared in literature when discussing external factors influencing women's self-efficacy perceptions in math and science.

Eccles' (1986) study on gender differences in academic achievement among college women argued that capable women might not enter male-dominated occupations such as engineering, due to the gender stereotypes associated with women who pursue male-dominated fields. No mention was made of their socialization experiences from childhood that impacted them and their beliefs of academic and career options. It is undeniable that the female USC-MESA seniors living "in the ghetto" are deeply affected by their environments and demonstrate the impact that socialization experiences have on academic options. For these students, going to college and pursuing a career in math or science refutes the gender stereotypes in their neighborhoods to "just get pregnant and make babies." But rather than succumbing to the expectations of their environment, the determination to break through that cycle of expectations motivates them.

The extant literature on the role of women's self-efficacy perceptions in math and science on college major choice does not focus on the connection the women have with their neighborhood communities as a factor that influences self-efficacy perceptions. Research on women's self-efficacy perceptions in math and science that have addressed environmental and societal factors have translated these factors to be parent and teacher support without considering the roles played by the actual neighborhood environment and its messages (Eccles 1986; Farmer 1987; Oakes 1990). Data revealed a connection between students' academic pursuit and their neighborhood environments. The next section discusses a connection to their MESA community and the role it plays in fostering their self-efficacy perceptions in mathematics and science.

MESA Community

Participants express pride in belonging to a community in which they can find deep relational and intellectual connections. Deep friendships among the females have been forged over the past four years through common interests in math, engineering, and

science to a point where they would describe their communities to be "a second family" and MESA on their school campuses as their "second home." In contrast to their neighborhoods, participants describe the MESA community as a place where they "really fit in" and a place where they feel empowered about their college-bound future. One USC-MESA staff described the community as a place that provides the students an academic sense of belonging and the possibilities of where they can go. This opportunity gives room to explore their interests in the STEM fields and builds a strong sense of self-efficacy among the female students.

The four sources that foster self-efficacy perceptions are illustrated within the MESA community. In addition to mastery in math and science courses that the students must take in order to continue their participation in the MESA program, the annual competitions give the students an opportunity to improve from the previous year. The USC-MESA program acknowledges that competition is an efficacious way to prepare students for the STEM fields. Several participants expressed that these competitions helped them see how they can improve their projects for the following year and "keep in mind what they can do better." In addition, the chance to observe their peers performing a particular task or competition often communicates a positive message to the students that they, too, have the capability to perform the task. Bandura (1986) describes these as vicarious experiences for the students. One participant recounted her experience watching other students build a robot the year before she participated in the robotics competition and realized that she, too, was capable of doing something like that.

In addition to vicarious experiences, verbal persuasion, the third source that fosters self-efficacy perceptions, positively influences the self-efficacy perceptions among these students. The impact of verbal messages and social encouragement will be discussed in the following section, "Factors That Help or Hinder." Prevalent in the MESA community is the role of attitude or outlook as it relates to self-efficacy beliefs. According to Pajares (1996), individuals with high self-efficacy perceptions are not as susceptible to emotions of stress and depression when approaching difficult tasks but rather adopt a sense of optimism. The participants used words such as happy, proud, excited, encouraged, worthwhile, and capable in describing their experience in the USC-MESA program, in contrast to words such as fear, disconnect, struggle, difficult, unsafe, and scared when talking about their neighborhoods. Ethington and Wolfe (1988) examined the concept of attitude as an indirect role in course pursuit and field of study and suggested that women who possessed a positive attitude toward mathematics were more likely to select a quantitative college major. Although it can be asserted that the majority of female seniors in this study who plan to select quantitative college majors possess positive attitudes in math, researchers Ethington and Wolfe (1988) overlooked the context and process in which a positive math attitude can be fostered or the role social support can play on women's self-efficacy perceptions in those academic domains.

Lent and his colleagues (2003) explain the impact of perceived support such as the Society of Women Engineers (SWE) as one factor that contributes to women's self-efficacy in a nontraditional major in college. Like SWE, the MESA program focuses on

supporting women going into nontraditional majors and strives to eliminate social barriers prior to entering college. In the MESA community, staff and advisors dispel societal stereotypes of women entering traditionally male-dominated fields by creating room for the female students to explore their interests in STEM and creating a sense of belonging. It has been a place where the students have found peers who are similar to them and built on the camaraderie of mutual interests and hopes for the future. This type of support found in MESA, similar to Lent et al.'s (2003) examination of the impact of SWE, has lent itself to fostering a determination in the participants to dispel perceptions of what low-income schools are capable. The community found in the MESA program not only contributes to the participants' self-efficacy in a nontraditional area of study for women, but also contributes to building a strong self-efficacy perception among the participants that they can break societal stereotypes of people in low-income neighborhoods.

Research has taken quantitative approaches to find correlates and predictors of women's choice to pursue or not to pursue mathematics or STEM majors or created linear models such as the social cognitive career theory to connect academic achievement with career interests (Armstrong and Price 1982; Lent, Brown, and Larkin 1986). From the data, participants' self-efficacy perceptions in mathematics and science and their desire to pursue STEM majors have been influenced by the world around them. Based on their perception of their academic abilities, these students have a personal reason behind choosing to pursue a STEM major. Beyond the predictive model that those who are good in math will select a math-based major, their awareness of the needs that exist in the real world have led them down the STEM path.

Participants shared feelings such as "wanting to make the world a better place," "advancing our economics through science," and "helping to clean up the environment" as reasons for selecting a STEM major. Their real world appears bleak. However, their experiences in the MESA community has painted a different picture for them. This picture illustrates that going to college and pursuing a STEM major will be the exit from this reality in the "hood" and open doors to a better reality. A commonly shared sentiment was that the MESA program bridges what they are learning to the real world that lies ahead. Ethington and Wolfe (1988) attribute this positive attitude toward mathematics as an indication toward a likelihood of selecting a quantitative college major. Data from this study has shown that the combination of their positive attitude in mathematics and the possibility of what they are convinced they can accomplish through the study of mathematics has resulted in selecting a quantitative major. In addition, their strong self-efficacy perception in math and science has led them to foresee themselves as agents of hope for their own families and the world around them.

Factors That Help or Hinder

In the midst of living in two different worlds, these MESA seniors are attuned to the voices that communicate messages of hope and messages of hurt. These voices come from their families and teachers. This section juxtaposes the findings from the data with what literature posits about the impact of verbal messages on women's self-efficacy perceptions in math and science.

Family

According to Bandura (1977), social messages convince people that they are capable of succeeding at a particular task and affirm their competence. Zeldin and Pajares (2000) continued to profess the importance of verbal persuasions through their study of women currently in mathematics, science, or technology-related careers. Similar in response to the women in their study, the female MESA students regarded the verbal messages such as "The sky is the limit," "Keep your grades up," and "If you could go to college, go for it," as words of encouragement and affirmation from their family. These messages engendered an attitude in the women that they could do anything by building their confidence and empowering their abilities to face the toughest of challenges. In this case, the challenge is to be the first in their families to go to college. Zeldin and Pajares (2000) affirmed that the source of self-efficacy perception that comes from verbal encouragement and persuasion possesses a greater weight for women in male-dominated fields due to the academic and social obstacles they face. In addition, parents act as social forces that shape women's self-efficacy beliefs particularly in math (Eccles and Jacobs 1986). Though some parents from Zeldin and Pajares' study (2000), like most parents of these participants, did not have a career in the STEM field, the verbal messages instilled a "mental toughness" in their children in the face of obstacles. Both the women in Zeldin and Pajares' (2000) study and the female MESA students in this study had little trouble recounting messages of empowerment from family members in considering a STEM major or career. The female MESA students depend on these messages as a source of hope and encouragement for their futures. In addition to these verbal messages that instill confidence in them, the nonverbal messages that surround them also play into their determination for a better future.

The female MESA seniors carry the weight of being the first in their families to go to college. Throughout their lives, they have witnessed the financial difficulties of their parents and the hardships they experienced, which has communicated an even stronger message in them. The fear of never getting out of the "hood" and replicating the same struggles of their parents also serves as a motivation to tackle any obstacles ahead of them. Contrary to Pajares' (2002) finding that parents often underestimate their daughters' academic competence and hold lower expectations for them, the parents of this group of female seniors have high expectations for them. These high expectations have been communicated verbally and nonverbally throughout critical moments in their lives. Zeldin and Pajares (2000) found that these critical moments that women had with their parents and families propelled their self-efficacy perceptions. For the participants in this study, these moments have been witnessing the financial struggles of their parents or knowing that their moms come home after midnight from a full day of cleaning other people's homes. Families have served as their "active encouragers" as these participants work hard at having a better future for themselves and their families (Armstrong and Price 1982).

Teachers

In addition to family influences, participants shared encouraging and discouraging messages that have shaped their view on themselves and what they are capable of accomplishing. The extant literature is unclear about whether the impact of teachers'

beliefs in students' mathematical ability is as large as that of parents' beliefs. However, the role teachers play in developing female students' interest in math and science is undeniable (Armstrong and Price 1982; Eccles Parson, Kaczala, and Meece 1982; Eccles and Jacobs 1986; Zeldin and Pajares 2000). Some participants expressed dispassion in math due to their teacher's own disinterest in teaching the subject and had to "self-teach" themselves in the class. Another expressed a loss of passion in math and felt that a better teacher may have continued spurring their interest in the subject. Armstrong and Price (1982) stressed the importance of teachers playing a role in encouraging women's participation in mathematics through taking more mathematics courses and seeking out careers in mathematics. In this case, the participant decided she was not going to "veer into an engineering field" because the classes she took and the teachers no longer made the subject as exciting as she once experienced.

Other participants felt their teachers were pivotal in shaping their love for the sciences and have been instrumental in helping them determine their major in college. The same could be said of teachers and their role in encouraging students to pursue science. Several participants enjoyed their environmental science course and considered majoring in environmental sciences primarily because of their teacher's passion in the subject. One participant was convinced that "kids do not like math and science depending on the teachers they had before." Further, the impact of institutional support has played an integral role in the participants' continual interest and pursuit of the STEM field from high school to their college major choice.

Aware of the realities of their institution, the MESA advisors are determined to foster the students' interest in math and science despite the experiences the students have had with other teachers. They create a safe space for the students by matriculating with them from year to year as their MESA advisor and devoting time outside of their regular teaching responsibilities. Mr. Sanchez, one of the USC-MESA advisors, refuses to let his South Central students think they can be any less successful despite how others may judge them. Zeldin and Pajares (2000) believed that teachers, both male and female, were extremely influential in the development of students' competence and confidence. One participant shared that Mr. Sanchez encourages her to be confident in speaking and helps her overcome her shyness when leading her peers in MESA. In observing a teacher like Mr. Sanchez, it is evident that he believes his students are as capable as students from Beverly Hills or Venice High School of achieving and winning MESA competitions. The MESA students at his high school have been strong competitors in the USC-MESA Robotics Competitions for the past four years. Last year they placed first in the competition among LAUSD schools. Teachers such as Mr. Sanchez persist in being a voice of empowerment to the students, despite what colleagues may communicate to the same students, and are determined to help their students see that what they do from day-to-day has a purpose. In accordance with Zeldin and Pajares' (2000) findings, the female participants have been particularly responsive to the verbal messages of encouragement from their teachers and as a result, the female students have been as competitive in the MESA events as their male peers.

The MESA program seeks to reduce the number of historically underrepresented students in college and universities through academic preparation in the mathematics and science fields. More importantly, the goal is to incite interest in engineering, science, or other math-related careers among these students, activate their academic capabilities, and encourage a college-going culture. In an effort to advance the discussion of the mechanisms within the USC-MESA program that support these goals, we have developed the following policy recommendations.

Policy Recommendations

Based on the data findings, we have formulated the following recommendations for policymakers, administrators, and educators whose focus is on increasing the number of underrepresented populations in higher education. In particular, these policy recommendations are targeted for precollege programs such as USC-MESA, which partner with teachers and administrators at local schools to fulfill their mission of increasing access to college, and have been developed from the theoretical findings from this study. Despite the fact that the USC-MESA program is decentralized and carried out on different school campuses, general themes and areas of improvement can be implemented in the program as a whole, as well as on each campus. These suggested improvements or policy recommendations provide practical ways for the USC-MESA program and partnering schools to improve the self-efficacy perceptions of female high school students in mathematics and science and shed light into components of the precollege program that best encourage these students to choose STEM majors in college. The four recommendations are as follows: (1) cultivate parental involvement for parents of USC-MESA students; (2) garner institutional support; (3) maintain high program standards; and (4) increase partnerships with other USC programs to improve retention.

Cultivate Parental Involvement for Parents of USC-MESA Students

According to Jun and Colyar (2002), families play an integral role in the patterns of inequality from generation to generation. Many of the students in the USC-MESA program are seeking to break this cycle of inequality by becoming first generation college-goers. This often means navigating the college application and preparation process with little to no help from their parents as opposed to high and middle income families that have learned to navigate through the school system on their children's behalf (Lareau 1989). Within the USC-MESA program, there exists a need to involve families more directly.

Findings indicated that families played a large role in fostering a strong self-efficacy perception in mathematics and science through their verbal messages. The participants found a deep sense of self-confidence that they are able to achieve what their parents have never been able to do before. Their ability to face and overcome social and academic obstacles in their community and schools stemmed from the confidence built into them by their parents and family members. Given the stereotypes that discourage women from entering scientific careers, those aspiring to STEM fields will have a

different cognitive nature from those who accept conventional wisdom and do not challenge the status quo (Bar-Haim and Wilkes 1989). These women need family members and advocates who encourage them to be confident in their own judgment.

In the general MESA syllabus for the 2008–2009 school year, one parent orientation meeting was scheduled in the month of October and one session was held for parents to inform them about financial aid for college at the MESA College Day at USC. USC-MESA advisors expressed that a challenge to recruiting and retaining students in the MESA program at their schools was the lack of "parent buy-in." Within the USC-MESA program, parents generally are exposed to the college-going process. However, study results indicate that parents and families are integral in sending messages about what female students believe they are capable of achieving. It is important for key stakeholders in the program to implement a component that offers parents consistent resources to help the students successfully enter college. In addition, because parents are integral in communicating expectations for their daughters, it is important to inform and train parents on how to verbally and nonverbally encourage their daughter's future academic and career aspirations.

At one site, the MESA advisor initiated parent meetings every other month to inform parents to reinforce the importance of their participation in their child's success. These meetings offered diverse social networks and helped parents comprehend the power of social capital resources that could be gained through participating in these meetings. Creating consistent opportunities for parents of the USC-MESA students to realize their integral role in the college-going process, be it filling out financial aid forms or learning about college application deadlines, would not only assist in retaining students in the MESA program but also help the students break the cycle of inequality that has been passed on from previous generations.

Garner Institutional Support

In addition to cultivating parental involvement, institutional support is needed in a program like USC-MESA that is student-centered, focusing their resources on students who are selected and admitted into the program but primarily based on each school campus (Gandara 2002). Though the USC-MESA director holds a letter of support from each school administrator that has agreed to have the MESA program on their campus, MESA advisors have deemed administrative support as lacking but integral to the recruitment of students. MESA is a club on most high school campuses that meets at lunchtime with some and before or after school. One site in the study previously had MESA as a class period and found that schedule to be conducive to incorporating activities or facilitating science demonstrations. A noticeable drop in attendance occurred when the meeting time was moved to zero period as students were already over-extended in their extra-curricular activities.

The findings reveal that the quality of teachers in the math and science courses influence students' interest and desire to pursue the STEM fields. The majority of students expressed their interest in math and science despite the quality of institutional

support because the MESA program offered hands-on experience and helped them connect what they were doing in math and science courses to real-world applications. Evident in the impact that this program can have on students' self-efficacy perceptions in the domain, institutions should consider implementing a MESA period as an elective course to help retain students in the program and augment the regular curricular offerings in the schools. In addition, students who take elective mathematics and science courses after they complete their college preparation requirements will have more opportunities to prepare them to major in scientific fields in college (Oakes 1990).

Maintain High Program Standards

Having a well-trained and qualified staff focused on maintaining high program standards is a key determinant of a good program. The USC-MESA program currently is comprised of three staff members. Aside from the director of the program, the two other staff members collaborate on building the MESA curriculum—one member oversees the middle schools and the other staff oversees the high schools in the program. Each participating school has at least one advisor on campus who is a full-time teacher. In light of the data, the two high school sites had different focuses during their meetings. One campus spent the majority of the MESA meeting time preparing for competitions while the other campus spent little to no time discussing logistics of competitions but rather spent the majority of their meeting time talking about issues related to college-going such as college applications, personal statements, and applying for scholarships. While the goal of the USC-MESA program sets out to motivate and prepare disadvantaged students to become competitive and eligible to major in a STEM field at a university or college, it appeared that depending on the advisor and their personal strengths and character, the focus was usually on one or the other. The data revealed that the USC-MESA advisor's personal leadership characteristics and charisma had strong impacts on their students. The USC-MESA program would benefit from increasing the leadership training that occurs among the MESA advisors. As a result, MESA advisors who possess strong leadership characteristics could train new MESA advisors in how to effectively lead their program and students on their own campus.

Having an additional USC-MESA staff member dedicated to assisting advisors by coming to their campus to offer sessions on practical steps in college applications, conducting a session on writing personal statements, or filling out scholarship applications could lift the burden off advisors to squeeze both competition preparation and college-going issues in the once-a-week meetings.

Increase Partnership with Other USC Programs to Improve Retention

Recruiting and retaining targeted students in the MESA program has been a challenge for USC-MESA advisors. The challenges in recruitment have ranged from the meeting times, competition with other activities, lack of administrative support, to lack of student motivation. In 2005–2006 the percentage of USC-MESA student re-enrollment was 49 percent and climbed to 57 percent in the 2006–2007 school year. Not enough research has been conducted to further understand the challenges in the retention of

students in the program. Students who have left the program have not been contacted to better understand their reasons for leaving.

As one avenue to encourage students to continue participating from year to year, the USC-MESA program has offered a scholarship of $1000 for graduating seniors who have participated all four years in high school and are college-bound. Recognizing that most of these students come from low-income families and would need more assistance in going to college, USC-MESA should partner with other programs in the USC Community Education Academy to maximize the resources available for their students. These partnerships could improve the services available to parents as well as financial assistance targeted for promising students that USC-MESA is unable to offer with their limited resources. In addition, looking ahead to partner with organizations in colleges and universities that provide support for underrepresented students in STEM majors, such as the Society of Women Engineers, will not only help women in the transition from high school to college, but also provide a support system to help retain women in the major.

Conclusion

This study confirms the role of women's self-efficacy perceptions in mathematics and science in their college major choice. The findings from this study support USC-MESA's desire to foster an encouraging environment in which female students can find community and where social and academic obstacles traditionally found in the STEM fields are not present. It also brought forth the integral role parents, families, and teachers play in fostering self-efficacy perceptions of women in math and science. Precollege programs such as USC-MESA often stand alone in their mission to prepare historically disadvantaged students for college. In order for these students to be the first to go to college and graduate, a perfect intersection of advocates from their home, school, and community must commit to their success. Rather than attributing the success of these students to a program or school, we must examine why students themselves become outliers among their peers. Policy makers, educators, and program administrators must collaborate to ensure that rigorous evaluation of these intervention programs examine what works, for whom, and under what circumstances (Gandara 2002). In the current economic state, it is integral to re-examine how program resources are used, institutional dollars are spent, and whether students are receiving the highest margin of return for every dollar spent on advancing their futures.

References

Armstrong, Jane M. and Richard A. Price. 1982. "Correlates and Predictors of Women's Mathematics Participation." *Journal for Research in Mathematics Education* 13 (2): 99–109.

Bandura, Albert. 1977. "Self-efficacy: Toward a Unifying Theory of Behavioral Change." *Psychological Review* 84: 191–215.

Bandura, Albert. 1986. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, Albert. 1997. *Self-efficacy: The Exercise of Control*. New York: Freeman.

Bandura, Albert, Claudio Barbarnaelli, Gian Vittorio Caprara, and Concetta Pastorelli. 1996. "Multifaceted Impact of Self-Efficacy Beliefs on Academic Functioning." *Child Development* 67 (3): 1206–1222.

Bandura, Albert, Claudio Barbarnaelli, Gian Vittorio Caprara, and Concetta Pastorelli. 2001. "Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories." *Child Development* 72 (1): 187–206.

Bar-Haim, Gabriel and John M. Wilkes. 1989. "A Cognitive Interpretation of the Marginality and Underrepresentation of Women in Science." *The Journal of Higher Education* 60 (4): 371–387.

Eccles, Jacquelynne S. 1986. "Gender-Roles and Women's Achievement." *Educational Researcher* 15 (6): 15–19.

Eccles, Jacquelynne S., and Janis E. Jacobs. 1986. "Social Forces Shape Math Attitudes and Performance." *Signs* 11 (2): 367–380.

Eccles Parson, Jacquelynne, Caroline M. Kaczala, and Judy L. Meece. 1982. "Socialization of Achievement Attitudes and Beliefs: Classroom Influence." *Child Development* 53 (2): 322–339.

Ethington, Corianna A., and Lee M. Wolfe. 1988. "Women's Selection of Quantitative Undergraduate Fields of Study: Direct and Indirect Influences." *American Educational Research Journal* 25 (2): 157–175.

Farmer, Helen. 1987. "A Multivariate Model for Explaining Gender Differences in Career and Achievement Motivation." *Educational Researcher* 16 (2): 5–9.

Gandara, Patricia. 2002. "Meeting Common Goals." In *Increasing Access to College*, edited by William G. Tierney and Linda S. Hagedorn. Albany, NY: State University of New York Press: 81–103.

Hackett, Gail and Nancy E. Betz. 1989. "An Exploration of the Mathematics of Self-Efficacy/Mathematics Performance Correspondence." *Journal for Research in Mathematics Education* 20 (3): 261–273.

Jun, Alexander, and Julia Colyar. 2002. "Parental Guidance Suggested." In *Increasing Access to College*, edited by W. G. Tierney and L. S. Hagedorn, 195–215. Albany, NY: State University of New York Press.

Lareau, Annette. 1989. *Home Advantage*. London: The Falmer Press.

Lent, RobertW., Steven D. Brown, and Kevin C. Larkin. 1984. "Relation of Self-efficacy Expectations to Academic Achievement and Persistence." *Journal of Counseling Psychology*, 31, 356–362.

Lent, Robert W., Steven D. Brown, and Kevin C. Larkin. 1986. "Self-efficacy in the Prediction of Academic Performance and Perceived Career Options." *Journal of Counseling Psychology* 33: 265–269.

Lent, RobertW., Steven D. Brown, and Kevin C. Larkin. 1987. "Comparison of Three Theoretically Derived Variables in Predicting Career and Academic Behavior: Self-efficacy, Interest Congruence, and Consequence Thinking." *Journal of Counseling Psychology*, 34, 293–298.

Lent, Robert W., Steven D. Brown, Janet Schmidt, Bradley Brenner, Heather Lyons, and Dana Treistman. 2003. "Relation of Contextual Supports and Barriers to Choice Behavior of Engineering Majors: Test of Alternative Social Cognitive Models." *Journal of Counseling Psychology*, 50, 458–465.

Maple, Sue A. and Frances K. Stage. 1991. "Influences on the Choice of Math/Science Major by Gender and Ethnicity." *American Educational Research Journal* 28 (1), 37–60.

National Center for Education Statistics. 2004. *Projection of Education Statistics*. Alexandria, VA: U.S. Department of Education.

Oakes, Jeannie. 1990. "Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics." *Review of Research in Education* 16: 153–222.

Pajares, Frank. 1996. "Self-Efficacy Beliefs in Academic Settings." *Review of Educational Research* 66 (4): 543–578.

Pajares, Frank. 2002. "Gender and Perceived Self-Efficacy in Self-Regulated Learning." *Theory into Practice* 41 (2): 116–125.

Wolcott, Harry. 1975. "Criteria for an Ethnographic Approach to Research in Schools." *Journal for the Society of Applied Anthropology* 34 (2): 111–125.

Zeldin, Amy and Frank Pajares. 2000. "Against The Odds: Self-Efficacy Beliefs of Women in the Mathematical, Scientific, and Technological Careers." *American Educational Research Journal* 37 (1): 215–246.

Zimmerman, Barry J., Albert Bandura, and Manuel Martinez-Pons. 1992. "Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting." *American Educational Research Journal* 29 (3): 663–676.

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