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Self-efficacy in Career Choice of STEM Fields for Women Undergraduates

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Although females have made significant progress in the workforce, they are still under-represented in fields such as science, engineering and mathematics, and over-represented in traditionally female fields such as education. While several theories exist today that attempt to explain this gap, the theory of self-efficacy appears to be one of the most applicable to today's generation of students yet one of the least researched theories. This paper will focus female self-efficacy development as it relates to career-decision making for undergraduate females choosing math, science and engineering careers, and the aspects of their undergraduate experience which lead to strong career self-efficacy in choosing typically male career fields.

Women have made significant progress in the American workforce, currently comprising about 46% of wage earners (U.S. Bureau of Labor Statistics, 2006). They have also made great strides in education, where they currently represent the majority of students in undergraduate institutions, and are more likely than their male counterparts to persist in college, obtain degrees, and enroll in graduate school (Buchmann & DiPrete). However, gaps still exist between men and women in many key industries and occupations (Jacobs, 1995). Women remain underrepresented in fields such as science, technology, engineering, and mathematics ("STEM") fields, and overrepresented in traditionally female fields such as education. According to the most recent reports from the U.S. Bureau of Labor Statistics (2006), women make up only 26% of the 2.4 million engineers employed in the United States. In contrast, among elementary and secondary teachers in the United States, approximately 76% are female (U.S. Bureau of Labor Statistics, 2007).

Many propositions have been made that attempt to account for why such a gap exists. The variety of explanations include differences in academic preparation between men and women, differences in attitudes towards science between

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men and women, lack of female role models in the industry, a 'chilly climate' for women in science classes, and pressure to conform to traditional gender roles (Blickenstaff, 2005). However, none of these theories thoroughly addresses the role that self-efficacy plays within each of these proposed explanations, and more specifically, within the gender gap itself.

Self-efficacy is the belief that a person can succeed in a given domain (Bandura, 1986), and has been put forth as a potential theory to explain the gender gap that exists in the STEM fields. Although research is limited, the link between self-efficacy of both female and male students and their choice to pursue STEM fields appears to be the one theory that best applies to undergraduates today. Self-efficacy is one of the strongest predictors of success, both academically and vocationally (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). Students with positive self-efficacy beliefs are able to make decisions and choices, to value their own effort, to persist in complex tasks, and to better cope with stress and stressful events (Bandura, Caprara, Barbaranelli, Gerbino, & Pastorelli, 2003). Further, students with positive academic self-efficacy are likely to be more certain about career choices and to invest their efforts into the career decision making process (Nauta & Epperson, 2003).

This paper will review the literature surrounding career decision-making, and more specifically, female self-efficacy development as it relates to career decision-making for undergraduate women choosing STEM careers. It will discuss the aspects of the female undergraduate experience that lead to strong self-efficacy in choosing these typically male-dominated career fields. The specific factors connected to the college environment examined for their impact on self-efficacy include family influence, peer culture, academic experience, and industry knowledge and exposure. The goal of this paper is to use the current literature to better understand self-efficacy development for undergraduates and the factors that influence this development. This review will serve as a precursor for future research aimed at investigating how self-efficacy development may be influencing whether or not undergraduate women choose to pursue careers in STEM fields.

Family and Self-Efficacy

One factor that influences a student's self-efficacy development during the undergraduate years is family. This includes family relationships, expectations and pressures, gender stereotypes held by parents, as well as the educational and vocational achievement of family members themselves.

Theories behind birth order and family configuration suggest that where a student fits within the birth order (e.g., firstborn versus middle child), and how the parental unit is structured (e.g., married parents versus separated parents), can influence career self-efficacy (Leong, Hartung, Goh, & Gaylor, 2001). Firstborn children are often more inclined to turn to a parent or caretaker as a reference or model of behavior, gauging their own behavior or ability on a particular task. Non-firstborn children tend to turn to siblings more often as a reference or model of behavior, which is less ideal.

Cultural differences can also impact the development of self-efficacy. Members of cultures with a greater emphasis on autonomy tend to rely more heavily on individually based feedback to determine their level of self-efficacy, while those from cultures which are based more upon collectivism tend to rely more on group-based feedback (Early, 1994; Early, Gibson, & Chen, 1999). While this analysis of the relationship between family, siblings and the development of self-efficacy presents a strong foundation for understanding self-efficacy development in general, research is lacking with regard to how the role of family is maintained or changed during the undergraduate years. Self-efficacy may be more deeply impacted by the influence of family during a female's experiences in college than during her experiences prior to college.

The family systems perspective proposes that students' decision-making abilities around career choice are directly influenced by the quality of family interactions (Carr, 2000; Brachter, 1982). The family systems approach, as it relates to career development, suggests that the quality of a female student's interactions with her family, boundaries maintained within her familial relationships, and emotional dependencies and independencies with family members directly influence her ability to make decisions about her career direction (Brachter). Specifically, this entails emotional interdependencies related to academic and vocational issues, and parents' expectations regarding career paths (Kondrick, 2003; Hargrove et al., 2002). In some extreme cases, it may be the family system itself that determines the career options available and appropriate for a student, rather than the student herself (Brachter, 1982).

The relationship between family and self-efficacy is also revealed through the life expectations a student has for herself (Aveling, 2002; Kondrick, 2003). These expectations including establishing a family and finding a partner may play a particular role in the work-life balance the student will eventually develop. Family relations can influence these expectations, and in turn affect self-efficacy. A student may not believe that she can succeed in a particular career if

she feels that her life expectations would conflict with such a career.

While all of these studies clearly define a link between family influence and career decision making, research is lacking regarding the extent to which family influence impacts self-efficacy in career-decision making. Some of the literature suggests that there is a direct link between family influence and self-efficacy development. However, further research is necessary to understand how strong this link may be, and how family influence works in conjunction with other influences such as peer relationships and academic experiences.

<div align="center">Peer Relationships and Self-Efficacy</div>

A second factor that influences a student's self-efficacy development during the undergraduate years is peer relationships in both academic and social settings. Oftentimes, peer relationships impact the maintenance and development of self-efficacy through the mode of persuasion. Several recent studies have suggested a direct link between perceived expectations from peers and self-efficacy, from both educational and occupational standpoints (Chin & Kameoka, 2002; Bandura et al., 2001). Chin and Kameoka studied the psychosocial and contextual predictors of self-efficacy beliefs about educational and occupational attainment. While the target population was specifically Hispanic adolescents, the study and results yielded information about the influence of peer relationships on self-efficacy. The authors used Bandura's theory of self-efficacy to develop a questionnaire, assessing the students' self-efficacy beliefs as influenced by previous performance, vicarious experience, and social persuasion (Bandura et al., 2001). Although age and gender were not proven to be related to occupational self-efficacy, social persuasion strongly predicted self-efficacy for this sample population. The authors concluded that further research is needed to determine the role that social environments play in how self-efficacy is developed and maintained (Chin & Kameoka).

Additionally, Lee (2002) suggests that when students are engaged with peers who support academic and extracurricular involvement related to STEM fields, they become more organized around their involvement in such fields, and tend to actually increase their involvement as a result. Conversely, if students are unable to find or maintain relationships with peers who are supportive of the study of STEM fields, they tend to become "disadvantaged in terms of science, math, and engineering achievement" (Lee, 2002, p. 349). To examine this phenomenon, Lee (2002) analyzed a longitudinal study of 320 male and female students in STEM fields who were participating in a related summer program.

Using a framework of identity theory, he explored the ways in which their peer and social relationships and experiences impacted their involvement in STEM fields. Lee's research emphasizes the importance of peer relationships in shaping student involvement in math, science, and engineering both inside and outside of the classroom. This on-campus involvement then directly impacts the development of self-efficacy.

Academic Experiences and Self-Efficacy

A third factor that influences a student's self-efficacy development during the undergraduate years is academic experience. If females receive support in the classroom and experience academic achievement, especially in fields in which women are underrepresented, it is more likely that they will have expectations of success outside the classroom and in post-graduation career opportunities. More specifically, a female undergraduate student's career self-efficacy has been proven to be directly linked to her academic self-efficacy (Bandura et al., 2001). Similarly, undergraduates' perceptions of the classroom environment and academic experience have the potential to play a direct role in their overall satisfaction with the institution (Stage & McCafferty, 1992). Combining these two hypotheses may then suggest that institutional satisfaction impacts self-efficacy development based on the link between academic satisfaction, academic self-efficacy, and career self-efficacy.

Educators have the potential to influence an undergraduate woman's self-efficacy by recognizing her talent and encouraging her to pursue a particular area of study (Wolcott, 2001). Even today, researchers suggest that male students who excel in math and science have a much higher likelihood of being encouraged towards the study of engineering than their female counterparts (Wolcott, 2001). Self-efficacy can also be impacted by the particular teaching style, system of communication, and method of evaluation used by an educator. In fact, certain teaching styles appear to be especially beneficial to student self-efficacy development. Instructors who adopt such approaches in their classroom have a positive impact on their students' self-efficacy and the outcomes associated with such efficacy (Bandura, 1986; Bandura, 1997).

Experiences working with faculty on academic projects further aids in the development of female self-efficacy (Campbell & Skoog, 2004). One example of such an effort is the Texas Tech University/Howard Hughes Medical Institute (TTU/HHMI) Undergraduate Biological Sciences Education program. The program began in 1992, with the goal of increasing the number of undergradu-

ate women in the sciences by involving them in research laboratories and projects with faculty members (Campbell & Skoog, 2004). Female participants in the program reported increased skill level, confidence, and motivation to seek a science career (all aspects of stronger self-efficacy), as a result of the research experiences and mentor relationships that they had developed in the TTU/HHMI program (Campbell & Skoog, 2004).

More recently, Quimby and DeSantis (2006) further supported the relationship between self-efficacy and academic role models influencing career choice. They conducted a study of 368 female undergraduates at a Mid-Atlantic university using a survey that examined career choice, presence and influence of role models, and self-efficacy development. The researchers hypothesized that, "self-efficacy and role model influence accounted for significant variance in career choice" (Quimby & DeSantis, p. 297). Surprisingly, investigative careers (including science, mathematics, and engineering) were the only types of careers in which the presence of role models did not appear to influence career choice over and above the influence of self-efficacy. Yet Quimby and DeSantis proposed several reasons for future research on this particular finding, including the fact that previous research has indicated that students with role models of similar gender are more significantly influenced in terms of their career development (Karunanayake & Nauta, 2004), and that there are fewer women in investigative careers to serve as role models. The researchers concluded that the greatest need today is for female role models following nontraditional career paths.

Industry Exposure and Knowledge and Self-Efficacy

A final factor that influences student self-efficacy development during the undergraduate years is industry exposure and knowledge. The amount of knowledge that a student possesses about a particular career field, and in this case about STEM career fields, along with the reaction that a student may have to this knowledge, equally impact self-efficacy.

Today, more families than ever are founded upon a structure in which the woman is the "breadwinner" of the family. However, women are still more likely to be the primary caregivers when they have children (Aveling, 2002). As a result, a conflict may arise between women trying to fulfill both roles, serving simultaneously as primary caregivers and breadwinners. Women in Western nations are overwhelmingly reported to have expectations of marrying, having children, and having careers (Bridges & Orza, 1992). With these life plans must then

come an industry and career choice that allows for a balance of these many responsibilities and roles. This research suggests an increased concern with the ways in which women make career choices in relation to their expected family and spousal roles, and what type of industry exposure and knowledge women utilize.

Bandura's (1986; 1997) research on self-efficacy suggests that vicarious experiences may be one of the major influences on self-efficacy development. Self-efficacy beliefs are often formed around knowledge of how others have performed when faced with similar tasks. This form of "modeling," and whether or not a person feels that the model behavior is achievable, results in increased or decreased levels of self-efficacy (Bandura, 1986; Bandura, 1997). In turn, if women gather industry information and obtain vicarious experiences about a particular industry, and this information is in line with their own life plans (e.g., plans for a family, spouse) and sense of what they can achieve, then their self-efficacy will be stronger than if the industry information they gather challenges their life plans. Bandura's findings suggest if a woman is able to vicariously experience a person or job in an industry of interest to her, and the person being modeled possesses similar life plans, the woman would have a stronger level of self-efficacy in choosing a career in that industry. This more developed level of self-efficacy for a particular industry is signaled by a female's decision to choose a career path in the field, with the confidence that in choosing that career path, she will be able to incorporate her interests in developing her role as a spouse and parent.

Similar to the influence of peers and professors, mentors and role models from STEM industries can have a positive influence on female self-efficacy in these career choices (Wolcott, 2001). Based on the lack of females in these nontraditional career fields, however, undergraduate women often turn to members of the opposite sex as role models. This may include a family friend or male family member who serves as a career influence and source of support (Wolcott, 2001).

Research has also suggested that the sociological construction of careers and industry choices, whether they are constructed as gender-appropriate or not, further influences female self-efficacy development (Kondrick, 2003). Women are not as likely to choose or persist in career fields that have been socially constructed as gender-inappropriate (Kondrick, 2003). Kondrick (2003) suggests that one of the main reasons that women avoid career choices that may be gender-inappropriate stems from a fear of lessening their romantic appeal.

Conclusions and Needs for Future Research

This review of the literature suggests several explanations regarding the current gap that exists between men and women in choosing STEM careers, and the impact of self-efficacy on such career choices for undergraduate females. Further research is needed to better understand how female undergraduate students make their career decisions, and which aspects of the college environment are most influential in impacting their decisions. Such research will not only benefit higher education and its participants, but also the STEM fields themselves, which are in need of more talented workers. Specifically, it is critical to examine the direct role of self-efficacy in career decision making for women as it relates to factors such as family influence, peer relationships, academic experiences, and industry exposure and knowledge. With a better understanding of how self-efficacy develops for undergraduate women, the higher education environment can be better equipped to support today's students. This support may come in the form of providing women with the necessary knowledge and information, systems of mentorship, industry exposure, and career and academic advising that will promote high levels of self-efficacy, and in turn allow women to make solid career decisions, regardless of what is considered "traditional" or "nontraditional."

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