ABSTRACT

RYDER-BURGE, AMY REBECCA. Understanding How Women's and Minorities' Perceptions of Scientists Influence Students' Choice of Major. (Under the direction of Mary Wyer.)

Women and minorities are under-represented in science, technology, engineering and mathematics (STEM) fields (National Science Foundation, 2009a; National Science Foundation, 2009b.). Previous research exploring the reasons behind the under-representation of women and minorities in STEM fields has included interventions designed to target under-represented groups (Cuny & Aspray, 2000), family expectations and persistence in STEM fields (Mau, 2003), and gender differences in self-efficacy in STEM fields (Fassinger & Asay, 2006). While these studies usefully explore early influences on an individual's interest in STEM, they do not examine the impact of stereotypes' perceptions of a scientist and stereotypes about equitable opportunities in science and how they relate to choice in a STEM or non-STEM major.

This study looked at two new variables, scientist-self similarity (SSS) and critical vision (CV), and how they were related to student's choice in a STEM or non-STEM major. SSS captured differences between perceptions of scientists and perceptions of self. CV measured perceptions of opportunities in science in relation to gender and ethnicity. Gender and ethnicity of participants were included in the logistic regression analyses. SSS and gender were found to be significantly related to students' choice of major. For females, the odds of being a STEM major were lower as perceptions of scientists and perceptions of self differed more. For males, perceptions of scientists and perceptions of self did not relate to their odds of being a STEM major. Participants' gender, ethnicity, and CV score were found to be significantly related to student's choice of major. For

females, and most dramatically European American females, as perceptions of equal opportunities in science decreased the odds of being a STEM major increased. For males, regardless of ethnicity, perceptions of equal opportunities in science did not change the odds of being a STEM major. The results of this study suggest that a focus on scientist-self similarity and perceptions of equity would add to current interventions designed to address the under-representation of women and minorities in STEM fields.

Understanding How Women's and Minorities' Perceptions of
Scientists Influence Students' Choice of Major

by
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DEDICATION

To my family, thanks for the legacy you have left me, the love we have now, and a future that looks so promising.

BIOGRAPHY

Amy R. Ryder-Burge is originally from North Stonington, Connecticut and is the youngest child of Carolyn and Kenyon Ryder. She earned a B. A. in Psychology from the University of Connecticut in 2005. While she was there she had the privilege of working in the research lab of Dr. Blair Johnson. In 2005, she began her graduate studies in Psychology at North Carolina State University. For the first three years of her studies she worked as a research assistant in the Stereotypes Lab's Measurement Matters project under the direction of Dr. Mary Wyer, followed by a year teaching courses in the Psychology Department. Since April of 2009 she has worked with the Center for Family and Community Engagement as the Research Manager on the evaluation of the Strong Fathers Program.

Amy married Jason Burge of Hartford, Connecticut and Kingston, Jamaica in 2007. They live in North Carolina with their children: Ethan, Kingston, and Sean.

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Introduction

This research project seeks to understand some of the influences on college students' decisions to pursue science, technology, engineering and mathematics (STEM) related careers as indicated by their choice of major. In this field, women and minorities have been under-represented in the rates at which they receive STEM bachelor's degrees (National Science Foundation, 2009a; National Science Foundation, 2009b). By better understanding what affects an individual's decision to pursue a STEM career, future research can be focused on creating ways to increase women's and minorities' representation in STEM fields.

Research about decisions to pursue a STEM degree has focused on school, family and psychological issues. Some of the recommendations for change in school related issues include providing role models for under-represented groups (Cuny & Aspray, 2000), creating an equitable classroom environment (Tindall & Hamil, 2004), targeting STEM educational programs to under-represented groups (VanLeuvan, 2004) and increasing overall academic achievement for under-represented groups (Mau, 2003).

Familial expectations and involvement have been linked to educational expectations and achievement in STEM fields as well. The presence of a biological father for young inner city boys has been linked to their educational expectations (Cook, Church, Ajanaku, et. al., 1996). The role of family related variables was found to be related to educational and vocational aspirations (Mau & Bikos, 2000) and persistence in science and engineering (Mau, 2003). Both studies looked at perceived parental expectations, socioeconomic status, parental school involvement, parental academic involvement and number of siblings. Mau found that parental expectations were significantly related to persistence. Mau and Bikos found that socioeconomic status and parental expectations were both positive predictors of educational and occupational aspirations.

Confidence in abilities and understanding of STEM material are some of the psychological issues that have been raised as possible explanations for the lack of success in STEM programs for under-represented groups (Mau, 2003; Mau & Bikos, 2000; ; Fassinger & Asay, 2006; Jones, Howe & Rua, 2000). Mau and Bikos did not find math self-efficacy as a significant predictor or academic proficiency as a strong significant predictor of educational and occupational aspirations. However, Mau did find that these two variables were predictors of persistence in science and engineering. Jones, Howe and Rua found eight significantly different perceptions of science between male and female sixth grade students. They found that males were more likely than females to report that science was associated with power, easy to understand, helping the poor, destructive and dangerous, creates problems for society, and is most suitable for boys. Females were more likely than males to report that science was difficult to understand and associated with doing experiments. There were no significant differences by gender in the perception that science was useful for everyday life, important for society, interesting/exciting, creates pollution and is boring. Fassinger and Asay discuss case studies of women in STEM programs that internalize their shortcomings and difficulties in STEM fields. Self-efficacy, differing perceptions, and internalizing shortcomings are all psychological explanations for lack of success in STEM programs.

While these studies usefully explore early influences on an individual's interest in STEM, they do not examine the impact of stereotypes about gender and ethnicity and how they relate to perceptions of a scientist. This research study explored how perceptions about oneself and perceptions of science and scientists, gender, and ethnicity are related to student's choice of major. This research project also explored how perceptions of equal opportunities in science, gender, and ethnicity are related to students' choice of major.

Two measures were used as new variables: (1) perceptions of self in relation to perceptions of scientists and (2) perceptions of equal opportunities in science. The first measure, perceptions of self in relation to perceptions of scientists, is informed by research including: an image of a scientist as male (Mead & Metreaux, 1957), prevailing images of a scientist as a European American male among a diverse sample of students (Sumrall, 1995), including undergraduate students (Rahm & Charbonneau, 1997), and how images of a scientist translate into attitudes towards science and scientists (Krajkovich & Smith, 1982). The second measure, perceptions of equal opportunities in science, is informed by research that covers several topics including: how a person may need to adapt to certain gender roles in order to succeed in STEM programs (Seymour & Hewitt, 1997), how diversity and ethnic isolation affect perceptions of prejudice (Seymour & Hewitt, 1997), and how primed gender or racial/ethnic stereotypes affect academic performance (Kiefer & Sekaquaptewa, 2007; Schmader, Johns & Barquissau, 2004; Sekaquaptewa & Thompson, 2003; Shih, Pittinsky & Ambady, 1999). While academic performance was not explored in this study, this research does allow for the exploration of the impact of stereotypes in STEM fields. This study examined the similarity between how students perceive themselves and how they perceive scientists, as well as how students perceive equal opportunities in science. These measures of scientist-self similarity and perceptions of equal opportunities in science plausibly influence choice of major.

Under-Representation of Women and Minorities in STEM Fields

In order to understand how to change the under-representation of women and minorities in STEM fields, it needs to be understood how both groups are represented in different STEM fields over time. Until recently women and minorities have been under-represented populations in virtually all STEM fields (NSF, 2009a). The National Science Foundation provides national data to track the representation of individuals through STEM fields by gender and ethnicity (NSF, 2008). The STEM fields that are tracked by NSF include: agricultural sciences; biological sciences; computer sciences; earth, atmospheric and ocean sciences; mathematics and statistics; physical sciences; and engineering.

Table 1 lists in detail the percentage of women who have received bachelor's degrees, by field (excluding Psychology and Social Science degrees[1]), in 10 year increments from 1966 to 2006, in order to show how the representation of women in each field has changed over time. In 1966 women received 16% percent of bachelor's degrees awarded in science and engineering programs (NSF, 2000a). The most recent data from NSF show that in 2006, women received 39% of bachelor's degrees awarded in the same science and engineering programs (NSF, 2009a). This change has increased steadily over the past four decades. It can be seen in Figures 1 through 7 that women have made greater strides towards equality in some fields than others. Women are noticeably not as well represented in the number of degrees awarded in the fields of engineering and computer science. What is guiding these female students' movement towards (and away from) equal representation in STEM fields is still unclear.

When examining the representation of minorities in STEM fields, the same general upward trends that have been seen for women also appear but with less dramatic increases over time. Of the students who received bachelor's degrees in 1989, 76% of them were European American, 8% were Asian/Pacific Islander, 5% were African American, 4% were Hispanic, less than 1% were American Indian/Alaskan Native, 2% were of other or unknown race/ethnicity, 5% were nonresident aliens[2] (NSF, 2000b). By 2006, European American students earned 65% of the bachelor's degrees in science and engineering, Asian/Pacific Islander students earned 11%, African American students earned 7%, Hispanic students earned 7%, American Indian/Alaskan Native students earned less than 1%, students of other/unknown race/ethnicity earned 5%, and nonresident aliens earned 5% (NSF, 2009b). Table 2 lists the percentages of bachelor's degrees in science and engineering, by each field, citizenship, and race/ethnicity in five and six year increments from 1989-2006, Figures 8 through 14 display these same trends over time. This format allows for additional perspective on the representation of minority students attaining degrees in science and engineering fields compared to non-minority students (NSF, 2000b; NSF, 2009b). While there has been movement towards positive change, diversity in STEM remains a distant goal. The changes in the number of women and minorities that have received bachelors' degrees in different STEM fields could be compared to research that has been done over these same time periods and give some insight into what has and has not worked during these same time periods and what can be done differently.

Degree choice does seem to be related to students' gender and ethnicity but the NSF (2000a; 2000b; 2009a; 2009b) data alone do not explain why there are these differences. Seymour and Hewitt (1997) completed an in-depth qualitative analysis of students' persistence and attrition in STEM majors. Their results suggested that females and minority students did face obstacles to their success in STEM programs that were related to their gender or ethnic status. Research on topics such as science self-efficacy, (e.g., She, 1992; Ivie, Cujko & Stowe, 2002; Miller, 2006), gender stereotypes (e.g., White & White, 2006; Beyer, 1999), self-schemas (e.g. Lips, 1995), and stereotype threat (e.g., Sekaquaptewa & Thompson, 2003; Kiefer & Sekaquaptewa, 2007), among other topics have explored the relationships among gender, ethnicity, and decisions to pursue a STEM degree. However, none of these studies gives insight into how these students in under-represented groups perceive their under-represented status as an influence on their ability to obtain a degree in a STEM field. Students in under-represented groups can see, in their classroom, that they are under-represented, as can others. However, we know little about whether under-represented groups perceive themselves as different from their perceptions of scientists. Similarly, we know little about whether these students perceive themselves as having equal opportunities in STEM fields in regards to their gender and/or ethnicity, or how/if these perceptions affect their decisions to obtain a STEM degree.

The link between self and scientist

Males and females make very different decisions even when they are equally prepared for an occupational choice (York, 2008). Women are more likely than men to major in humanities and social sciences instead of mathematics, computer sciences or engineering (York, 2008). Some researchers argue that occupational aspirations and personal goals for women do not fit with a career in STEM fields. Frome, Alfeld, Eccles, and Barber (2006), for instance, found that desire for a flexible job, high time demands of an occupation (in a male dominated field), and low intrinsic value of physical science predicted that women's occupational aspirations veered away from a STEM field. These desires and personal expectations were also found in the work by Seymour and Hewitt (1997), and affected the ability of some women to see themselves as scientists. Other researchers argue that women self-select out of STEM fields by underestimating their abilities. VanLeuvan (2004) found that women underestimate their intelligence and their math and science competence, choosing not to pursue a STEM career as they move through high school. VanLeuven noted that "high school girls often underestimate their mathematics and science competence, feel less adequate, and have lower expectations for success in mathematics and science when compared to boys" (p. 249). While measures of competence, adequacy and expectations are useful they are not measures of stereotypes, which is the focus of this study. What we can learn from VanLeuvan is that women and men appear to have different occupational expectations and different self-perceptions about their ability to succeed in a STEM field. These differences may lead to differences in choice of major. However, research linking perceptions of self and occupations is rare.

Ancis and Phillips (1996) did examine the link between self-efficacy and perceptions of the academic environment and found that there was a significant relationship between the two. Female students' perceptions of gender equity in the campus environment were a significant predictor of student's beliefs that they could reach their career goals. A high perception of gender equity was significantly related to a strong belief that a student could reach his or her career goals. This research may be applicable to STEM fields. The perception that STEM fields are equitable may encourage under-represented groups to believe that they can reach their career goals in STEM fields. Ancis and Phillips also help to show the importance of the link between the self and how it is related to our perceptions of the academic environment.

Images of Scientists as European American Men

Researchers have been exploring images of scientists for over 50 years to understand stereotypes about science professionals and science careers. These studies document the persistent presence of a scientist as male and European American. This next section examines the stability of this perception over time.

Mead and Metraux (1957) launched social studies of stereotypes about scientists by examining images of scientists among high school students. Their research included several objectives including: exploring what comes to students' minds when asked to discuss scientists in general, what comes to mind when asked to think of themselves (or their spouse) as becoming a scientist, and whether (or not) the positive and negative images that are generated from these questions cluster together. The results from Mead and Metraux's (1957) analysis found a generally shared image of a scientist. A sampling of the characteristics of a scientist described in the article are that "the scientist is a man who wears a white coat and works in a laboratory,… he is surrounded by equipment, …and he spends his days doing experiments" (p. 386-387). Most of these characteristics have remained salient throughout the past five decades. The white lab coat the scientist is wearing, with crazy wiry white hair and glasses, working with test tubes and Bunsen burners are all images of a scientist that have remained embedded in our culture for at least 50 years (e.g. Buldu, 2006; Chambers, 1983; Sumrall, 1995;).

Mead and Metraux's (1957) study was designed to capture the then-common stereotypical images of a scientist. However, the *most* common and enduring characteristic of a scientist, unstated in the objectives of the study and unmentioned in the discussion of the results, was the scientist's gender. In nearly every description the scientist was depicted as being male.[3] At the time that this study was conducted, the gender of the stereotypical scientist and its implications were not evaluated.

In 1983, Chambers developed a new tool that could be used to evaluate people's stereotypes of scientists called the Draw-a-Scientist Test (DAST). This tool relied on the earlier study by Mead and Metraux (1957). However, Chambers' (1983) study sought to measure the participants' perceptions of scientists through the images that they created when drawing a picture of a scientist. In this study Chambers' sought to determine at what age children began to develop distinctive images of a scientist. Chambers' also looked at the influence of population variables, including gender, on participants' stereotypical images of a scientist.

The DAST is a simple test where participants are asked to draw a picture of a scientist, without any previous discussion on the topic. Chambers (1983) chose seven indicators as representative of the stereotypic image of a scientist. Chambers sampled 4,807 children from kindergarten to fifth grade. Chambers determined that a stereotypic image of a scientist was evident by second grade and that by fourth and fifth grade the image had fully emerged.

Chambers (1983) also found that there were demographic differences in the images drawn. For instance, only 28 children (girls) in this study drew women scientists and no boys did so. Although no comprehensive quantitative analyses were reported in this article, the results suggest that the stereotype of scientist-as-male emerged relatively early and was widespread among children in his study.

The results from Mead and Metraux (1957) and Chambers (1983) studies together have provided the foundation for later research findings that there are clear stereotypes about scientists, including but not limited to what they do, what they look or dress like, what tools they use, and their gender. However, the DAST in particular has been critiqued on methodological grounds. Follow up studies have found that the DAST may not measure actual knowledge about scientists and that interpreting gender and ethnicity from children's drawings may be subject to interpretive bias.

Sumrall (1995) conducted a study looking at the perceived images of scientists by race and gender to address these issues and to explore the interplay between gender and ethnicity. Sumrall's study was conducted on 358 students in grades 1 through 7. Each student was administered the DAST, followed by a series of questions about their drawing and recorded demographic information about the participants.

This research study was able to develop several empirically based conclusions. Males and females, European and African Americans all indicated some of their most salient images of a scientist based on these same demographic characteristics. 81% of European American boys drew a European American male scientist. While only 40% of European American girls drew a European American female scientist, 42% of African American boys drew an African American male scientist and finally, 26% of African American girls drew an African American female scientist. These results suggest that each gender and ethnicity category has distinct perceptions about whether their specific gender and ethnicity category is seen as a scientist. It suggests that European American boys had the easiest time seeing their gender and ethnic category as a scientist. They also suggest that participants who were not European American and/or male had a more difficult time seeing a scientist as representative of the same demographic characteristics that they are themselves.

Kleinman (1998) discussed how the persistent image of the prototypical Western, European American man may serve as a filter, limiting girls and women's abilities to see themselves as successful scientists. Sumrall's (1995) study provides supporting evidence by showing how the image of a European American male scientist is common among students that are not European American males. In this study 53% of European American girls, 42% of African American boys and 23% of African American girls drew a European American male scientist. The perception of a scientist as a European American male was common in this sample of students who were neither European American and/or male. If the prototypical image of a Western, European American male scientist is a filter for girls, then we can see the implications of Sumrall's study for these girls. The fit of viewing a scientist as similar to oneself in relation to one's gender identity is meaningful. Furthermore, it may be equally important to understand how that fit (between self and scientist) is related to one's ethnic identity as well. Sumrall's findings suggest how young students' images of scientists may be associated with their sense of themselves, and their gender and ethnicity.

While the work of Sumrall (1995) allows us to see children's perceptions of scientists gender and ethnicity and how they relate their own gender and ethnicity this study does have some limitations. The only significance tests and results that are discussed are related to race. In the study, European American girls drew significantly more European American scientists than of any other race. This study would benefit from a clear analysis of any significant differences in the percentages of a scientist drawn with a given gender and ethnicity compared to the gender and ethnicity of the participants. When trying to understand the complex role of gender and ethnicity and how it is related to perceptions of science, a clear explanation of how any results differ by gender and ethnicity would only serve to help future interventions better focus on what work needs to be done to increase the representation of women and minorities in STEM fields.

Most of the research we know about the saliency of the image of a scientist has been conducted on grades K-12 but data suggest relevance at the college level as well (Rahm & Charbonneau, 1997). Research suggests that college students hold the same stereotypical images of scientists that had been previously found in students in grades K-12 (Rahm & Charbonneau, 1997). Yet college students are a population that is expected to be making and/or to have made decisions about their future career. Research on younger students indicates there are patterns in stereotypes about scientists by race/gender that may help explain patterns of choices about undergraduate majors, by race/gender.

Gomillion (2007) examined undergraduate students', perceptions of scientists and how the perceptions are related to student's choice of major. Gomillion's sample was 48 African American students that were either science (n = 17) or non-science majors (n =

31). In this study, participants were administered the Draw-a-Scientist Test (Chambers, 1983) and the results were analyzed using the Draw-a-Scientist Test Checklist (DAST-C). The DAST-C measures the presence of 15 common stereotypes of scientists found in literature (Finson, Beaver & Cramond, 1995). The greater number of items marked on the checklist indicates more stereotypic images of a scientist. Gomillion (2007) compared the average means of science and non-science majors to see if they held different perceptions of scientists. A *t*-test analysis revealed that the two groups did not have significantly different means ($t(46) = .44$, $p = .69$), indicating that African American undergraduates did not have differing perceptions of a scientist depending on their major (science or non-science). The non-significant findings are based on the average scores from the 15 DAST-C indicators. Two indicators include drawing a male scientist or drawing a European American scientist. Included in Gomillion's (2007) analysis is a table of the percentages of participants by major that had a specific indicator present in their drawing. Two indicators, the scientist's gender and ethnicity did have dramatically different percentages of representation between the science and non-science majors. Forty-one percent of science majors drew a male scientist compared to 61 percent of non-science majors, a difference of 20% between majors. This difference indicates that the image of scientist as male was more common among non-science majors than among science majors. Fifty-three percent of science majors drew a European American scientist compared to only 23 percent of non-science majors, a difference of 30% between majors. This difference indicates that the image of a scientist as European American was more common among science majors than non-science majors in the study. Though the average difference between science and non-science majors was not significant, responses to these two items suggest that perceptions of scientists by gender and race may have particular salience for some students.

In order to gain a better understanding of the results that Gomillion (2007) found between science and non-science majors drawings of a scientist with a male gender and a European American ethnicity, a contingency table analysis was conducted. First, a contingency table analysis was conducted to examine whether major (science vs. non-science) was related to the gender of a scientist that was drawn (male vs. other). Results indicate that there was not an association between major and gender of a scientist (X^2 (1) = 1.79, $p > .05$); that is, the participant's major (science or non-science) was not related to an increased likeliness of drawing a male scientist (or a scientist of another gender category). Secondly, a contingency table analysis was conducted to examine whether major (science vs. non-science) was related to the ethnicity of a scientist that was drawn (European American vs. other). Results indicated that there was an association between major and ethnicity of a scientist (X^2 (1) = 4.55, $p < .05$); that is, a non-science major was related to an increased likeliness of drawing a scientist with an ethnicity other than European American.

African American science majors may have an increased likelihood of presuming scientists are European American. On the other end of the spectrum, African American non-science majors may have an increased likelihood of presuming scientists are non-

European American. The perception of a scientist as being other than ones' own ethnicity may play a role in the decision to pursue a STEM major. While there was a failure to find a significant relationship between major of participant and gender of scientist drawn in this sample the differences between science and non-science major's perceptions of a scientist as male do exist in Gomillion's study, and may exist in a larger sample. Many other students, including African American non-science/non-STEM majors, may presume scientists are male. Clearly many African American science majors have not been deterred from their STEM interests by their stereotypes of scientists. Thus emerges several questions: is there a differing perception of science depending upon one's ethnic or gender stereotype of a scientist? Will a racial or ethnic stereotype increase the odds of a member of a racially or ethnically under-represented group wanting to pursue a STEM degree? Will a gender stereotype decrease the odds of a woman wanting to pursue a STEM degree? Finally, will a stereotype based on perceptions of equal opportunities in STEM fields relating to gender or race/ethnicity affect the decision to pursue a STEM degree?

The results of Gomillion's (2007) study and the subsequent analysis on the gender and ethnicity of the scientist drawn show the possibility that the perception of a scientist's gender and/or ethnicity are related to students choice of major. Exploratory analysis of Gomillion's work indicates a direction in the relationship between major and ethnicity of a scientist drawn. This study shows that there is a relationship between major (science vs. non-science) and perceptions of a scientist (gender and ethnicity). However, stereotypes of a scientist are more complex than whether a scientist is perceived as being male or female. Now is the time to take this research beyond drawings of a scientist and extend the research to a larger sample of students who may or may not be under-represented in STEM fields to see if this relationship is maintained and how.

We know from the work of Krajkovich and Smith (1982) that individuals hold perceptions of scientists that reflect personal and work related characteristics. This perception carries us further than the work of Chambers (1981) and the DAST, beyond the presence of beakers, lab coats and white men. The Image of Science and Scientist scale (ISSS) measures work related images such as sitting in a lab all day, family life perceptions such as the item “is rarely home,” and personal characteristics such as the item “is patient.” The ISSS has shown gender differences in images of scientists (She, 1992). Knowing that women and minorities are under-represented in STEM fields, it is useful to explore how individuals images of scientist may differ by the gender and ethnicity, as She (1992) did for gender, and to see if we can change those images, as She (1992) found that you can. Thus, this research process can be taken a step further by comparing how those images of work, family, and personal characteristics of a scientist to those same characteristics to oneself. This process is similar to the work that was done with the DAST. Sumrall (1995) took care to report the gender and ethnicity of the scientist drawn and how it related to the gender and ethnicity of the participant who made the drawing. We know from his work that there were vast differences in this comparison. When we compare the images of a scientist in the ISSS to how one perceives themselves on these images will we also see differences across gender and ethnicity? Will those differences predict student's choice of major?

Perceptions of Equity

Seymour and Hewitt (1997) completed an in-depth qualitative analysis of the reasons that students leave STEM programs. Data were collected from 335 students at seven different universities through personal interviews or in focus groups. Specific characteristics of students were identified (e.g., race, sex, major, SAT score) and were used to identify a possible sample population for the study from each university. Participants were chosen for a variety of different variables. The selection variables included whether their major choice indicated they had selected out of a science, mathematics or engineering (SME) degree and they had high SAT scores, indicating that they would do well in an SME field. Once students were determined to have met the selection criteria, students were contacted at random to participate in the study, deliberately over-sampling students who had a history of being from under-represented groups in SME fields. This was a three-year study designed to identify factors that impact undergraduate students' decisions to switch from science, mathematics, and engineering majors to non-science based majors. Seymour and Hewitt concluded that preparation, learning experiences, career and lifestyle choices, time and money, issues related to gender, and issues related to race and ethnicity each played a key role in student's decisions to stay in or switch out of SME majors.

The research of Seymour and Hewitt (1997) provides fresh and constructive insight into persistence and attrition in relation to ethnic status. Seymour and Hewitt found ethnic variations in educational socialization that may be related to retention in STEM majors. These different educational socialization experiences were identified as different learning styles that can be a function of being accustomed to different teaching styles. Teaching styles that may be present at predominantly minority schools evolve into developing different study skills as a result of the individualized attention received prior to arriving at college. It appears that the teaching and learning environment on a college campus is more similar to the environment of high schools that are not composed of predominately minority students. In essence, students who come from high schools predominantly composed of minority students are not similarly prepared for the learning environment in STEM programs on college campuses as compared to students that do come from a learning environment composed of predominantly non-minority students. This difference in preparation can put minority students at a disadvantage.

Seymour and Hewitt (1997) identified some cultural attributes that seem to be related to an increase or decrease in the number of minorities in STEM programs. Some cultural attributes or character traits that may increase a minority student's success in a STEM fields include a feeling of obligation to serve one's community, being a role model and, for African Americans, the values of autonomy and independence. Unfortunately, there are several cultural attributes or character traits that negatively impact a minority student staying in a STEM program. Mainly, negative cultural attributes that are put upon a specific ethnic group by another (predominant) ethnic group seem to influence a minority student's perceptions of success in a STEM field. These negative influences can lead to an internalization of negative stereotypes. This process seems to be related to a student's degree of ethnic isolation and perceptions of prejudice, as well as minority group enrollment levels and perceptions of racism. Seymour and Hewitt (1997) theorized, based on their data, that an internalized negative stereotype can cause those who perceive it to have serious doubts about their abilities. This dynamic is widely supported by other research as well (Sekaquaptewa & Thompson, 2003; Shih, Pittinsky & Ambady, 1999; Schmader, Johns & Barquissau, 2004; Kiefer & Sekaquaptewa, 2007).

A logical result from the impact of internalized negative stereotypes is that doubts about abilities as a function of one's ethnicity will impact persistence in a STEM program. Seymour and Hewitt (1997) touched on the importance of students' perceptions in relation to their persistence. In general, minority students reported feeling isolated and targeted by prejudice, while European American students perceived the campus as relatively free of racial tensions and prejudice. In general, European American students' perceptions of racism among their peers were somewhat patronizing, informed by stereotypical ideas and reflecting a generalized good will towards minority groups.

The perception of prejudice and racism did not hold a direct relationship to the representation of minority students on the college campus. Seymour and Hewitt (1997) found that, at more diverse institutions, minority students in STEM fields felt more accepted but European American students expressed more resentment towards minority groups. At less diverse institutions, minority students in STEM felt prejudice but European American students expressed less prejudice and more favorable attitudes towards ethnic groups.

These results suggest that increased diversity as a solution to the underrepresentation of minority and female students in STEM fields may only be a partial solution. Seymour and Hewitt (1997) suggested that the need for increased diversity needs to shift to the concept of increased equity. Seymour and Hewitt's qualitative study suggests that students' perceptions about equal opportunities in STEM may be an important element of students' decisions to major in STEM, especially for minority students. All of the factors that Seymour and Hewitt identified as having a role in student's decisions to stay in or switch out of a SME major are worthy of additional research. Perceptions of SME (and technology) fields related to gender and ethnicity may be the most relevant in helping to understand student's decisions to pursue a STEM degree. This project will explore whether the perception of equal opportunities in STEM programs is associated with students choice of a STEM major.

Stereotypes and academic performance

While it is beneficial to understand how people perceive scientists, the link between this and subsequent participation in science programs also needs to be understood. Ultimately, we need to understand what it means to perceive a scientist a certain way. The connection between the perception of a scientist and its importance in making decisions about one's future is complicated. The role of stereotypes on academic performance can give some insight into the relationship between perceptions of scientists and participation in STEM fields.

In recent years, ample evidence has emerged to indicate that stereotypes can have a tangible influence on academic performance. Stereotypes carry a lot of preconceived notions about a group of people. However, stereotypes are not only about "others." People hold stereotypes about a vast array of different groupings of people such as women, African Americans, immigrants, lower income families, the chronically unemployed, the disabled, the elderly, etc. It is not unlikely that as members of our culture we will stumble upon stereotypes that represent part of who we are and our life circumstances. Stereotypes impact the systems in which we live. Crawford (2006) describes how this occurs, "stereotypes become part of the self-schema and may cause stereotype threat and create harmful self-fulfilling prophecies; they reinforce differences in status and power; and they prime sexist behavior and lead to discrimination" (p. 83). Crawford (2006) continued the discussion on occupational stereotypes and their gender differences. All of these possible by-products of stereotypes are applicable to the unequal representation of women and minorities in STEM fields as they impact academic performance. Research by Kiefer and Sekaquaptewa (2007); Schmader, Johns, and Barquissau (2004); Shih, Pittinsky and Ambady (1999); and Sekaquaptewa and Thompson (2003) show how stereotypes about science and scientists can become part of the self-schema and affect performance. This research provides evidence for a relationship between negative (and positive) stereotypes with academic performance for under-represented groups in STEM fields.

Students' decisions to pursue a STEM graduate degree as well as immediate performance on a math test are related to whether they hold a strong gender or ethnic identification with an under-represented group along with an implicit belief that someone like them is not associated with STEM fields (Kiefer & Sekaquaptewa, 2007). Kiefer and Sekaquaptewa sampled 63 undergraduate women who were enrolled in first year calculus classes. This study found two significant predictors of final exam performance in a math class and subsequent career goals for pursuing graduate school in mathematics. These predictors were gender identification and implicit gender stereotyping regarding math aptitude. Gender identification measured the degree to which being a woman was central to their self definition. Implicit stereotyping was measured with an Implicit Association Test, using reaction times to measure cognitive associations between words associated with four categories: Math, Humanities, Female and Male. Female students who held a high level of gender identification and had a high level of implicit stereotyping did not perform as well as their counterparts on the final exam and were less likely to express an interest in a math related career. Kiefer and Sekaquaptewa (2007) concluded that understanding the relationships between stereotypes, gender identity, and career interests may contribute to understanding women's underrepresentation in mathematics.

Schmader, Johns and Barquissau (2004) further explored the role of stereotype endorsement and women's subsequent performance. In the first study they sampled 86 female undergraduate math majors. The participants in the study were asked a series of survey questions measuring how likely it was they would continue in the field, their self-perceptions, their endorsements of stereotypes about men and women's math ability, legitimizing beliefs about status differences between the sexes and, status boundaries for women and Protestant work ethic. In the first study Schmader et al found that women who endorsed negative stereotypes about women's math abilities were significantly less confident in their ability to succeed, had significantly lower performance self-esteem, and reported less desire to go to graduate school.

In the second study 68 European American female undergraduate students in an introductory Psychology course were randomly assigned to one of two groups. In both groups students were told that a male researcher was developing a math test and would be personally evaluating their performance on the test. Students assigned to the control group were told that the researcher was interested in their individual performance and that their individual scores would be compared to the individual scores of other students. Students in the control condition were told to put their first initial and last name on the top of the test. Students in the experimental condition were told the same information as the control group but were also told that the researcher was interested in how women score on the test relative to men. In addition to their name, the participants were asked to write their gender at the top of the test. After both groups of students completed the test they were surveyed on gender identity threat and expected gender differences.

In their second study Schmader, Johns and Barquissau (2004) confirmed the finding that women who endorsed a negative stereotype about women's math abilities performed worse on a math test when their gender identity was made salient. They also found that women who rejected this stereotype showed no effects of this stereotype threat. Both forms of stereotyping had an impact on performance: those who held the gender stereotype that there are gender differences in math ability (study 1) and those who held a view that other people expect men to do better (study 2) performance decreased compared to participants who did not hold those views.

Sekaquaptewa and Thompson (2003) give some insight into how under-representation in STEM fields, along with stereotypes, is related to performance in STEM fields. Sekaquaptewa and Thompson (2003) wanted to see if the effects of stereotype threat and solo status affected subsequent performance. In this study, 157 European American male and female participants were randomly assigned to one of four conditions. Participants were either assigned to a stereotype threat or no threat condition. Then they were either assigned to a group with three other participants who were either their same gender (non-solo status) or all of the opposite gender (solo status). All participants were then given math related information as if they were part of a classroom conducted through a video conferencing method. They were then tested on what they had learned while they believed that the other members of their group were watching them answer the questions.

Females in Sekaquaptewa and Thompson’s (2002) study performed differently depending on the condition they were assigned to. When testing math performance of female participants who believed they were the only female in the group (solo status), females’ performance decreased when compared to female participants who believed that they were in a group of their same gender. This study also found that when a stereotype threat (about women) was suggested, women participants’ performance was negatively affected. Finally, this study found that when stereotype threat and solo status were combined women performed the worst, compared to when only one threat to performance was activated. This information adds to the importance of understanding the negative effects of low representation in STEM fields for women and minorities and how it can be compounded with negative stereotypes about STEM fields.

Another interesting dimension to this study was that while solo status and stereotype threat individually and together negatively impacted women’s performance, for the men in this study neither solo status or stereotype threat (individually or together) impacted their performance. Men’s performance was the same across all conditions, indicating those men’s perceptions of stereotypes or solo status did not impact their performance in STEM fields.

There is limited literature focusing on how negative stereotypes about STEM fields affect minority students. In a unique study, Shih, Pittinsky and Ambady (1999) focused on Asian-American women and the conflicting stereotypes of “women as bad at math” versus “Asian-Americans as good at math.” In their experiment, they compared performance on a mathematics test for a group of women primed as Asian American (n = 16), one primed as women (n = 14), and a control group with a neutral prime (n = 16) (questions related to phone and cable service). At Time 1, all participants were given a mathematics test. They then asked study participants to complete a survey that asked questions related to the group's prime. After this survey, another mathematics test was administered. When female identity was made salient females performed worse than both the control group and the "Asian-American" prime group. When Asian-American identity was made salient, participants performed better compared to both the control group and the female identity group. The results of this study demonstrate how stereotypes may have an impact on self-images in interaction with gender and ethnicity. Through this study we learn that ethnic stereotypes appear to affect performance just as gender-based stereotypes do. Secondly, we learn that stereotypes can have positive as well as negative effects on performance.

The literature on the influence of stereotypes on performance (Kiefer & Sekaquaptewa, 2007; Schmader, Johns & Barquissau, 2004; Sekaquaptewa & Thompson, 2003; Shih, Pittinsky & Ambady, 1999) is fascinating but is limited to concrete outcomes for students. Most of the research on stereotype threat looks at the negative effects of stereotypes and their immediate effects on performance. This literature does support the notion that people do experience stereotypes as part of the context of how they take tests. However, it provides limited insight into the complex information that makes up a stereotype. Stereotypes are plausibly related to decisions about major on the assumption that students chose majors that they perceive they can do well in, in the long term. This literature is a limited way to document the images and impact of stereotypes because it is oriented to an experimental and not a real world situation. The fact that a one-time primed stereotype does impact performance for students based on their gender and ethnicity suggests that a lifetime of cultural messages reflecting stereotypes could have a powerful impact. This study proposes to explore if stereotypes about scientists will affect not their performance in STEM fields but if they choose to participate in STEM fields at all.

Research Hypotheses

1. SSS score will be significantly related to student's choice of major (STEM or non-STEM). Participants' perceptions that scientists are similar (or dissimilar) to how they view themselves will impact their choice of major.
    a. Gender of the participants will be significantly related to student's choice of major (STEM or non-STEM).
    b. Ethnicity (European American or non-European American) of the participants will be significantly related to student's choice of major (STEM or non-STEM).
    c. Participants' SSS score, gender and ethnicity together will be significantly related to student's choice of major (STEM or non-STEM).

2. CV score will be significantly related to student's choice of major (STEM or non-STEM). Participants' perceptions that opportunities in science are as they should be will impact their choice of major.
    a. Gender of the participants will be significantly related to student's choice of major (STEM or non-STEM).
    b. Ethnicity (European American or non-European American) of the participants will be significantly related to student's choice of major (STEM or non-STEM).
    c. Participants' CV score, gender and ethnicity together will be significantly related to student's choice of major (STEM or non-STEM).

SSS score and the CV score were independent variables that were used in separate analysis to predict major (STEM or non-STEM), the dependent variable. Gender and ethnicity were added as independent variables to each model to control for their effect on the direction and the strength of the relationship between the SSS and CV scores with the dependent variable. Logistic regression was used to test the two main hypotheses.

Methods

Participants

The data for this study are from data collected as a part of the NSF-funded project, "Measurement Matters." The sample population for this study is 1112 undergraduate students from North Carolina State University. Participants for this study were recruited through two methods. One group of participants were enrolled in

Introductory Psychology courses and elected to complete the survey in order to fulfill research credits required for the course (n = 257). The second group of participants (n = 855) were obtained through cooperating professors and instructors who agreed to assist in inviting students in their courses to be surveyed. Students were encouraged to participate in the study. Though participation was voluntary, some professors awarded the participants with extra credit for completing the survey. Participants were sampled from several different courses including; biological sciences, psychology, chemistry and biomedical engineering. One-thousand, one-hundred and six participants indicated their major. Fifty-five percent indicated that they were a STEM major (n = 612), 29% indicated that they were a non-STEM major (n = 323) and 16% were either undecided in their choice of major (n = 32) or had a major that was not listed in the survey (n = 139). Students who were either a STEM major or clearly indicated that they were not a STEM major were included in this analysis (n = 935). Those who do not fit these categories (those who selected undecided or other major) were dropped from all remaining analysis. Of those who could be categorized into STEM or non-STEM majors 61% of the participants that completed the survey disclosed themselves as female (n = 566) and 38% disclosed themselves as male (n = 357). This compares to the percentages of females (57.8%) and the percentage of males (42.2%) who received bachelor's degrees in 2006 (NSF, 2009a). The sample for this study does have a higher rate of females than is representative of the percentage of females (44.1%) and males (55.9%) enrolled at the same campus during the time period that the data for this study were collected (North

Carolina State University, 2009). Of the participants who indicated their ethnicity 78% were European American (n = 729), 7% were Asian American/Asian (n = 65), 7% were African American (n = 63), 4% indicated "other" for their ethnicity (n = 36), 2% did not disclose their ethnicity (n = 21), 2% were Latino American/Hispanic (n = 16) and 0.5% were Native American/Pacific Islander (n = 5). The distribution of participants gender and ethnicity by major (STEM or non-STEM) is in Table 3. Other demographic variables about the participants were measured as well including number of years at their university, marital status and citizenship.

Psychometric Information

The goal of this research project is to explore the relationship between scientist-self similarity, perceptions of gender and ethnicity equity in STEM, and decisions to be a STEM major. In this proposed study, the first independent variable, scientist-self similarity (SSS), was distilled from the item responses about stereotypes of scientists in relation to parallel items about self-images (see appendix A). The original items in this section were composed of 113 statements designed to measure perceptions of scientists and perceptions of oneself. Fifty-seven items measured perceptions of scientists, and 56 matching items measured perceptions of oneself.

Items for this section were developed based on items in the Image of Science and Scientists Scale (ISSS). The ISSS was designed to assess students' attitudes towards science (Krajkovich & Smith, 1982), drawing on a much earlier study by Mead and Metreaux (1957). The SSS variable was created to measure the difference between the participants’ perceptions of scientists and how they perceive themselves. Items used to create the SSS variable measuring perceptions of scientists have strong face and content validity. The SSS difference score could then be used to explore how perceptions of self and scientists are, in combination, related to other variables of interest. A smaller score in this analysis will indicate that a participant perceives herself/himself and a scientist as similar. For instance, if a participant has a zero for their SSS score, then they perceive themselves in the same way that they perceive scientists. The SSS measure was created by subtracting how they view themselves (items in section 1B in Appendix A) from the matching item from how they view scientists (items in section 1A in Appendix A), measuring the absolute value of the difference between each matching item. The average difference score for the sum total of all matching items was used to create the SSS variable.

The second independent variable, critical vision (CV) score, was distilled from item responses about perceptions of equal opportunities in science (items in section 2 in Appendix A). The items in this section are composed of 24 statements about perceptions of equal opportunities in science in relation to gender and ethnicity. With the exception of two items, the items in this section were designed to parallel each other measuring beliefs about what should be compared to what is. The Women in Science Scale (WISS; Erb & Smith, 1984) was adapted for use in this section. The WISS was designed to measure attitudes towards women in science careers. Four items from this scale were adapted. One item was reworded to measure ethnicity as well as keeping the item that measured gender. Three other similar items were used measuring gender and were duplicated to measure ethnicity. Then the six items were duplicated again to measure whether participants felt that it *should* be as the item suggests and whether the participants felt that things *are* as the item suggests. The items in this section measure perceptions of equality in science on three separate constructs: employment opportunities, educational opportunities, and successful science careers. Items measuring perceptions of equal opportunities in science have both strong face and content validity.

The CV score was created by subtracting one item in section 2 (in Appendix A) from the other, obtaining the absolute value of the difference between the two. How participants perceive whether there *are* equal opportunities in science was subtracted from whether they perceive that there *should be* equal opportunities in science. The resulting score measures the degree to which each participant for each set of matching items feels that the opportunities that women and minorities have in science are the way that they should be, their critical vision. The average of each CV score for each matching set of items was measured to create the total CV score.

Both analyses include information about the participants' gender and ethnicity to determine how they are related to the dependent variable along with each independent variable (SSS and CV score). Ethnicity is determined by self-report based on several choices: European American/Caucasian/White, Asian American/Asian, African American/Black, Latino American/Hispanic, Native American/Pacific Islander, or other. Due to the small samples sizes of participants in certain ethnic groups, analysis on ethnicity for this study sorted all participants into one of two categories, European American (n = 729) and non-European American (n = 206). Major was categorized as STEM or non-STEM major. In the original data set, the choice of majors included 37 choices for participants to select. One choice included “other not listed major” and another choice was “undecided.” Participants who selected either of these choices were not included in the analysis. A STEM major was determined by a participant selecting from a choice of 21 STEM majors. The STEM major choices included: agricultural, animal science, biochemistry, biomedical engineering, biology, botany, chemical engineering, chemistry, civil engineering, computer engineering, computer science, electrical engineering, horticultural science, industrial engineering, mathematics, materials engineering, mechanical engineering, microbiology, physics, statistics, and zoology. A non-STEM major was determined by a participant selecting from a choice of 14 non-STEM majors. The non-STEM major choices included: anthropology, business and marketing education, elementary education, English, general studies education, math education, middle grades education, natural resources, philosophy, political science, psychology, science education, sociology, and technology education. Further variables for analysis that were discussed in the literature review and could be used as possible covariates in this study were not in the data set that was used.

This research project looks into perceptions of science (indicated by scientist self similarity score and critical vision score) and how they are related to student’s choice of major (science or non-science). However, the underrepresentation of women and minorities extends beyond science to technology, engineering and mathematics; fields that, while different in their research focus, are similarly grouped (as such we have the common acronym “STEM” for this grouping). Student’s choice of major could be grouped into several categories but for the purposes of this study grouping the participants into STEM and non-STEM major categories allows for the broadest look into how the two groups may have differing perceptions.

Results

Scientist Self Similarity Score

Hypothesis 1 analyzes participants’ scientist-self- similarity (SSS) score, gender and ethnicity, and how they are related to students’ choice in major. In order to conduct the analysis of hypothesis 1, an EFA was completed on the survey items measuring observations of scientists. Table 4 shows the items that were included in the measure of perceptions of scientists.

Prior to beginning the EFA, descriptive statistics of all 57 items were run including measures of the Kurtosis and Skewness of each item. The items in this section were designed to measure people’s stereotypes about scientists, looking for moderate levels of agreement and disagreement with each item. Some items had high agreement or disagreement and were removed from the analysis because that would not add any new knowledge to observations of scientists. For this reason, items with a Kurtosis value higher than 4.0 and lower than .40 were removed (Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010). At this stage a total of 21 items were removed. Using the same logic, items that had low skewness (less than .40), indicating a lack of a clear perception of a scientist in regards to these items, were removed. At this stage a total of 5 additional items were removed.

EFA using principal axis factoring with promax rotation was run on a randomized sample of half of the participants (n = 445) in the total sample (Field, 2005). Factors were determined by having an eigenvalue of 1.0 of higher. Two factors were found in this set of items. Items were then removed from analysis if they did not load at .40 or higher. A total of 13 items were removed. At the conclusion of this analysis there were 18 items measuring observations of scientists that loaded on two separate factors. One item was removed because it had no matching item in the observations of self survey items. Factor one has 11 items, explains 23.39% of the variance and a Cronbach's alpha of .82, indicating that this factor is reliable. Conceptually factor one measures professional competencies of scientists. Factor two has 6 items, explains 10.32% of the variance and a Cronbach's alpha of .68. Conceptually factor two measures interpersonal competencies of scientists. While this is lower than the desired value of .70, for an exploratory analysis this value is considered acceptable and reliable (Field, 2005).

The SSS score (n=935) was created to analyze the first hypothesis in this study, that participants perceptions of themselves as similar or dissimilar to how they perceive a scientist will be related to their odds of being a STEM major. The SSS score was created by matching up the perceptions of scientist items with the perceptions of self items. Participants' responses for each item about self were subtracted from their response about scientists. The absolute value of this score was then computed for each item set and the mean of these scores for all 17 items was computed. The mean SSS score was 0.85 (*SD* = 0.38). The minimum SSS score was 0.00 and the highest score was 2.82. These results indicate that participants had a fair amount of agreement between how they viewed themselves and how they viewed scientists. A score of 0 indicated that participants viewed themselves and scientists as similar. Higher scores indicated less similarity in these views, with a maximum possible score of 5.

Logistic regression was used to test hypothesis 1, that SSS score would be related to student's choice of major (STEM or non-STEM). Gender and ethnicity were included in the model. A logistic regression analysis was conducted to determine if gender, ethnicity and SSS score were significant predictors of whether a person was a STEM major or a non-STEM major. In this analysis, the probability of the model chi-square (34.47) was $p < 0.001$, $r^2 = .037$. For this model the null hypothesis was rejected. The existence of a relationship between gender, ethnicity, SSS score and major was supported.

Classification indices of sensitivity and specificity were analyzed to determine how many participants in this model were correctly or incorrectly classified for the dependent variable. For this study, specificity tells us the percentage of non-STEM majors that were correctly classified as non-STEM majors in the model. The specificity of the model was low at 7.5%. The sensitivity tells us the percentage of STEM majors that were correctly classified as STEM majors. The sensitivity of the model was high at 94.9%.

These two classification indices may indicate that when including SSS score, gender, and ethnicity in the model, STEM majors held together strongly as a group and that non-STEM majors did not. Grouping all of the non-STEM majors where they are all alike in only that they are not STEM majors may be a limitation of the model. It is likely that non-STEM majors are very different in their characteristics just by the nature of the broad array of majors represented in the group.

Step 1 of the logistic regression analysis included testing the main effects of gender, ethnicity, and SSS score on major (Table 5). In this step, significant main effects were found for SSS and ethnicity. The results for each independent variable are presented below.

SSS score was significantly related to major, supporting hypothesis one. Controlling for ethnicity and gender, the Wald statistic for the variable SSS score was 29.81 ($p < .001$). The value of Exp(B) was 0.36. With every unit increase in Scientist-self similarity score there are 64% lower odds of being a STEM major than a non-STEM major. Non-STEM majors had a mean SSS score of .94 ($n = 323$) and STEM majors had a mean SSS score of .80 ($n = 612$). These results support the hypothesis that having a low SSS score increases the odds that a participant is a STEM major and that having a high SSS score decreases the odds that a participant is a STEM major.

Controlling for ethnicity and SSS score, the Wald statistic for the variable gender was .47 ($p > .05$). The value of Exp(B) was 1.11. There was no significant relationship between participant's gender and major.

Non-European Americans were significantly more likely to be STEM than non-STEM majors, reflecting the higher proportion of STEM majors in our sample. Controlling for gender and SSS score, the Wald statistic for the variable ethnicity was 6.0 ($p < .05$). The value of Exp(B) was 1.56. Minority (non-European American) students in this sample were 56% more likely to be a STEM major than a non-STEM major. This effect is likely due to the sampling procedures used for this study. Non-European Americans, whether STEM or non-STEM majors, had higher mean SSS scores than European Americans in the sample. European American participants in this study had a mean SSS score of .82 (n = 729). Non-European American participants in this study had a mean SSS score of .94 (n = 206).

The significant main effects for ethnicity and SSS score were combined with the other independent variables in the model, creating three 2-way interactions and one 3-way interaction. R^2 in step one was .037 and increased to .047 in step two. These interaction terms were created to fully explore the relationship of these variables with the dependent variable, student's choice of major. Table 6 shows the odds ratios of being a STEM major with all three independent variables and their interactions (gender by SSS, ethnicity by SSS, gender by ethnicity, and gender by ethnicity by SSS). This table shows a significant relationship between gender and major as well as significant relationship between gender by SSS and major. The interaction results show that for every unit increase in SSS score females were 70% less likely to be a STEM major than a non-STEM major.

The probability of being a STEM major by the significant interaction of gender and SSS score is displayed in Figure 15. The range of SSS scores is displayed by the mean SSS score, as well as one standard deviation below the mean and one standard deviation above the mean. These scores are displayed for females and males who were European American and non-European American (see Table 10). The change in probability of being a STEM major for females by SSS score is different than for males. For males in this sample, the change in SSS score does not appear to be related to the probability of being a STEM major. For females in this sample, the odds of being a STEM major were lower as SSS score increased.

Critical Vision Score

Hypothesis 2 analyzed participant's critical vision (CV) score, gender and ethnicity, and how they are related to students' choice in major. In order to conduct the analysis for hypothesis 2, an EFA was completed on the survey items measuring perceptions of equal opportunities in science. Table 7 includes the items that were used to measure perceptions of equal opportunities in science. EFA with principal axis factoring with promax rotation was run on a randomized sample of half of the participants (n = 468) in the total sample (Field, 2005). Items were loaded on a 2 factor solution and were dropped if they had factor loadings less than .40. At the conclusion of this analysis there were 14 items. Factor one has seven items, explains 32.51% of the variance, and has a Cronbach's alpha of .89, indicating that the factor is reliable. Factor one captures perceptions of equal opportunities in science as they *should be* happening. Factor two has seven items, explains 24.31% of the variance, and has a Cronbach's alpha of .90, indicating that the factor is reliable. Factor two captures perceptions of equal opportunities in science as they *are* happening. These two factors then formed the basis of the CV score.

The CV score was created by matching up items measuring perceptions of how equal opportunities in science *should be* with the items measuring how they *are*. Participants' responses for each item about how things *are* were subtracted from their response about how they *should be*. The absolute value of this score was then computed for each item set and the mean of these scores for all 14 items was computed. The mean CV score was 1.53 (SD = 1.14). The minimum CV score was 0.00 and the highest score was 5. The mean score indicates a moderate amount of agreement in participant's perceptions that opportunities in science are as they should be. A score of 0 indicated that participants perceived that opportunities in science were as they should be. A higher score indicated less agreement in these views, with a maximum possible score of 5.

Logistic regression was used to test hypothesis 2, that the CV score would be significantly related to student's choice of major (STEM or non-STEM). Gender and ethnicity were included in the model. A logistic regression analysis was conducted to determine if gender, ethnicity and CV were significant predictors of whether a person was a STEM major or not. In this analysis, the probability of the model chi-square (9.09) was $p < 0.05$. For this model the null hypothesis was rejected. The existence of a relationship between gender, ethnicity, CV score and major was supported.

Classification indices of sensitivity and specificity were analyzed to determine how many participants in this model were correctly or incorrectly classified for the dependent variable. For this study, specificity tells us the percentage of non-STEM majors that were correctly classified as non-STEM majors in the model. The specificity of the model was low at 0%. The sensitivity tells us the percentage of STEM majors that were correctly classified as STEM majors. The sensitivity of the model was high at 100%.

These two classification indices may indicate that when including CV scores, gender, and ethnicity in the model, STEM majors held together strongly as a group and that non-STEM majors did not. Grouping all of the non-STEM majors where they are all alike in only that they are not STEM majors may be a limitation of the model. It is likely that this group is very different in its characteristics just by the nature of the broad array of majors that they represent.

Step 1 of the logistic regression analysis included testing the main effects of gender, ethnicity, and CV score on major (Table 8). Controlling for ethnicity and gender, the Wald statistic for the variable CV was 5.60 (p <0.05). The value of Exp(B) was 0.86. With every unit increase in critical vision score there are 14% lower odds of being a STEM major than a non-STEM major. Non-STEM majors had a mean CV score of 1.62

(n = 323). STEM majors had a mean CV score of 1.48 (n = 610). In summary, perceiving opportunities in science as being what they should be was related to being a STEM major or not being a STEM major. These results support the hypothesis that having a low CV score increases the odds that a participant is a STEM major and that having a high CV score decreases the odds that a participant is a STEM major.

Controlling for ethnicity and CV Score, the Wald statistic for the variable gender was 1.18 ($p > .05$). The value of Exp(B) was 1.18. There was no significant relationship between participant's gender and major.

Controlling for gender and CV score, the Wald statistic for the variable ethnicity was 4.52 ($p < .05$). The value of Exp(B) was 1.46. Minority (non-European American) students in this sample were 46% more likely to be a STEM major than a non-STEM major. European American participants in this study had a mean CV score of 1.44 (n = 728). Non-European American participants in this study had a mean CV score of 1.83 (n = 205). The significant main effects for ethnicity were likely due to similar sample effects as discussed in hypothesis one.

The significant main effects that were found were combined with the other independent variables in the model creating three 2-way interactions and one 3-way interaction. R^2 in step one was .010 and increased to .016 in step two. These interaction terms were created to fully explore the relationship of these variables with the dependent variable, student's choice of major. Table 9 shows the odds ratios of being a STEM major with all three independent variables and their interactions (gender by CV, ethnicity by

CV, gender by ethnicity, and gender by ethnicity by CV). Table 9 shows three significant relationships between the IVs and major. These are: ethnicity and major, ethnicity by CV and major, ethnicity by gender by CV and major. The results of the three-way interaction suggest that for every unit increase in CV score female minority students were 101% more likely to be STEM major than a non-STEM major.

The probability of being a STEM major by the significant interaction of gender, ethnicity and CV score is displayed in Figure 16. The range of CV scores is displayed by the mean CV score, as well as one standard deviation below the mean and one standard deviation above the mean. These scores are displayed for females and males who were European American and non-European American (see Table 11). The change in probability of being a STEM major for European American females and non-European American females by SSS score is different than for European American and non-European American males. For European American and non-European American males in this sample, the change in CV score does not appear to be related to the probability of being a STEM major. There is a difference for males by ethnicity in the probability of being a STEM major but that difference does not appear to be related to CV score. For females in this sample, the odds of being a STEM major were higher as CV score increased. These probability rates for females do differ by ethnicity. For non-European American females the probability rates of being a STEM major are high across all three levels of CV score, rising slightly as the CV score increases. For European American females the odds of being a STEM major ranged from .75 to .94. The odds of being a

STEM major became higher as CV score increased. CV score is related to the probability of being a STEM major for females and most dramatically for European American females.

The results confirm hypothesis 1, gender and SSS score interact in their relationship with major. The results also confirm hypothesis 2, gender, ethnicity, and CV score interact in their relationship with major. Both findings add to the current understanding of why students do or do not choose a STEM major. The match between sense of self and stereotypes of scientists (SSS score) is related to choice of major for females. The perception of equal opportunities in science is related to choice of major for females, especially European American females. For males, SSS score and CV score are not related to choice of major.

Discussion

The measure of SSS score moves the discussion of stereotypes about scientists beyond stereotypical images of scientists (e.g. working with beakers, wearing glasses, being male) to informing the characteristics of these stereotypes. The items measuring stereotypes of scientists, used to create participants SSS score, explore stereotypes about the professional and interpersonal competencies of scientists. These stereotypes of scientists extend previous research allowing for the exploration of similarities and differences in SSS score across groups; including gender, ethnicity, and major (Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010). The results of this study indicate that differences in major vary by SSS score and gender. For women, the odds of being a

STEM major become significantly lower when women do not see themselves as possessing the professional and interpersonal competencies that they perceive a scientist as possessing. Just as interesting, are the results suggesting that for males, seeing oneself as more or less similar to a scientist was not related their choice in major. What appears to be a barrier for one group does not appear to be so for another.

Gender differences in SSS score and their relationship to choice of major adds to the theoretical literature exploring the impact of stereotypes on student's choice of major. This study suggests a "real world" example of the effect of stereotypes beyond measures of stereotypes and stereotype threat that are often constructed in a laboratory setting (e.g. Schmader, Johns, & Barquissau, 2004; Sekaquaptewa & Thompson, 2003).

Gender differences in SSS score and their inverse relationship to women's probabilities' of being a STEM major can be applied to programs designed to increase the representation of women in STEM fields. The results of this study suggest that when women are more likely to see themselves as possessing similar professional and interpersonal competencies of a scientist they are more likely to choose a STEM major. This information can be added to workshops with the understanding that similarities between self and scientists are important and may be key to increasing the representation of women in STEM fields.

Just as stereotypes of scientists are related to student's choice of major, perceptions of equal opportunities in science are also related to choice in major. Additionally, perceptions of equal opportunities in science (as indicated by CV score) interact with participant's gender and ethnicity in determining their relationship to student's choice of major. These results were most notable for European American women. For this group, the odds of being a STEM major become higher as CV score changes from one standard deviation below the mean CV score to one standard deviation above the mean.

For women in general, an increase in CV score is related to the odds of being a STEM major being higher. These results suggest that perceptions of unequal opportunities in science increased the odds of women being a STEM major, especially for European American women. These results are different than expected, as it appears that perceptions of inequality are not a barrier to choosing a STEM major. It is unclear why perceptions of inequality were not a barrier to choosing a STEM major for women in the sample, especially including European American women. As these results were in the opposite direction than expected, it is possible that instead of being a barrier, perceptions of inequality, may be perceived as an opportunity for certain populations. These results suggest that a more detailed analysis of participants by different STEM majors as well differences among participants with low or high CV scores could shed some more light on the association between perceptions of inequality and choice of major.

For men in this sample, CV score was not related to the probability of being a STEM major. There were differences in the probability of being a STEM major between European American and non-European American males but this difference does not appear to be related to CV score. For males, an increase in perceptions of inequality in science did not affect the probability of being a STEM major. For males, these results suggest decisions to pursue a STEM major are not related to perceptions of equality or inequality in science. In summary, for males perceptions of equality may not influence decisions to be a STEM major. This same trend may be present for women who do perceive equality in science. These women's CV scores are interpreted as one standard deviation below the mean CV score. It is possible that for these women, perceptions of equality may not largely influence their decision to be a STEM major. However, as perceptions of equality in science decrease they begin to impact European American women and, to a lesser extent, non-European American women's decisions to be a STEM major.

The findings from this study reveal some limitations. The first limitation may be related to the deliberate sampling of participants in STEM fields, resulting in an unequal distribution of STEM and non-STEM majors. For instance, while SSS score and CV score do predict differences in being a STEM major by gender and ethnicity they do not explain all of the differences found by gender and ethnic group in their probabilities of being a STEM major. In most circumstances, non-European Americans in this sample had higher probabilities of being a STEM major than a non-STEM major. These probabilities appear to be unrelated to SSS score or CV score and may be a result of the sample obtained for this study.

The results of this study would benefit from increased data from under-represented groups in STEM fields. The small number in this study led to the grouping of all under-represented groups into one category (non- European American). It would be beneficial to examine differences in scientist-self similarity scores and critical vision scores for multiple under-represented groups with larger numbers that are more evenly balanced between STEM and non-STEM majors. Evidence of this was found when testing hypothesis one. The relationship between SSS score and major found a significant main effect for ethnicity, and this was likely due to sample effects. The significant main effect of ethnicity directly reflects the sample of this population for this study. Thirty percent of the non-White sample were non-STEM majors (n = 145) and 70% were STEM majors (n = 61). These significant results reflect the sampling procedures for the study that included sampling from STEM courses at a higher rate.

This study broke down choice of major into two groups, STEM and non-STEM majors. These groupings were useful in this exploratory study of the two new measures of SSS and CV score. Based on the results of this study it would be beneficial to see if similar results would be found for more discrete grouping of STEM and non-STEM majors. For instance, SSS and CV were based on perceptions of scientists and science. It is possible that there may be differences in these perceptions within STEM fields (e.g. science and engineering majors) or between specific STEM and non-STEM fields (e.g. science and science education majors). The results of this study suggest that there is room for future analysis to explore how perceptions differ by separating STEM majors into four (or even smaller) groups. Additionally, if the reference group in the items measuring SSS score and CV score was changed from Science fields to a reference to Technology, Engineering or Mathematics fields more field-specific results about STEM-self similarity and perceptions of equal opportunities may emerge, adding to our understanding of the under-representation of women and minorities in STEM fields.

This research project was designed to gain increased understanding around two new variables (SSS score and CV score) and how they may influence college students' decisions to pursue STEM-related careers as indicated by their choice of major. Women and minorities have been under-represented in the rates at which they receive STEM bachelor's degrees (National Science Foundation, 2009a; National Science Foundation, 2009b). This study tested the relationship between SSS score and major, and CV score and major. Gender and ethnicity were included in both of these models. The inclusion of gender and ethnicity allowed for the intersectionality of two types of general social identities with SSS score and CV score to predict the odds of being a STEM major (Shields, 2008).

This study found a significant interaction of gender and students' perceptions of scientists as possessing similar professional and interpersonal competencies as themselves, as indicated by their SSS score, with choice of major. The second significant finding of this study is an interaction of gender, ethnicity, and perceptions of equal opportunities in science, as indicated by CV score, with choice of major. For both CV score and SSS score the odds of being a STEM major for males in this sample did not change with an increase or decrease in CV or SSS score. For females, the odds of being a STEM major decreased with an increase in SSS score. For CV score, this trend for females reversed. The odds of being a STEM major increased with an increase in CV score. This trend was most dramatic for European American females.

The work of Seymour and Hewitt (1997) was the first of its kind exploring, through qualitative research, choice of major (in or out of STEM fields). Their research provided insights into students' sense of belonging in STEM. The results of their work reflected student's gender and ethnic identities as part of their sense of belonging in STEM fields. The results of this study support and extend these findings. Gender and ethnicity are related to choice of major in STEM fields, when taking into account SSS score or CV score. For women a high SSS score may be barrier to choosing a STEM major. For European American women a high CV score increases the odds of being a STEM major.

Seymour and Hewitt suggested that the focus on increased diversity in STEM fields needs to shift to a focus on increased equity. The results from hypothesis one, suggest that perceptions of a scientist as being similar to oneself does increase the odds that women will be a STEM major. This perspective of equity, or more specifically in the case of SSS score, similarity, is different than one of diversity which would instead emphasize that women can be scientists too.

For hypothesis two, the differing effects of participant's CV score on major by gender and ethnicity of the participant show that the perception of inequality for European American women leads to different choices. For these participants, it is surprising that the choice of STEM major appears to be linked to a sense that equity in science needs to increase. These results suggest that these participants are going into STEM majors aware of inequality in these fields. These participants may see themselves as agents of change. The findings from the examination of SSS score and CV score are provocative for designing interventions to promote and advance women in science.

If scientific professions hope to increase diversity in their ranks, interventions focused on cultivating student's perceptions that their skills and abilities are suited for science may attract a more diverse sample of students into STEM fields. Increasing the number of women and minorities in STEM fields isn't just about showing women and minorities that they can be scientists too. Women would benefit from interventions designed to show that they possess qualities and attributes that are similar to scientists. Women (minorities and non-minorities) would also benefit from interventions that emphasize the important role that they have and continue to play in advancing equity in science. Applying and further exploring this information could bring STEM fields a step closer to the diversity that it desires and knows it will benefit from (Mervis, 2000).

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Footnotes

[1]In 2006 women received 77% of all psychology bachelor's degrees and 54% of all Social Science bachelor's degrees (NSF, 2009a). In 2006 minorities (defined as race/ethnicity other than European American) received 33% of all Psychology degrees and 37% of all Social Sciences degrees (NSF, 2009b). Also, when examining this information from NSF, the trends of representation of women and minorities in Psychology and Social Sciences have increased only slightly since 1997. This information suggests that women and minorities are well represented in Psychology and Social Science fields and have been so for the past ten years.

[2]It is recognized that race/ethnicity for certain groups has been described using several different terms to represent one group. For this study, including all discussion of participants from cited research studies, participants that are referred to as European American, Caucasian, and/or White participants in a sample population will be described as European American. African American and Black participants in a sample population will be described as African American.

[3]These results could reasonably be influenced by the methodology used to collect data. First, it was not specifically stated what the demographic characteristics were of the sample population that was used to collect data. Also, male and female participants in the study were given different forms to complete when asked to think about themselves as scientists. In these forms females were given an additional option to answer the question instead of thinking about themselves and think about the person that they were going to

marry instead and were asked to think about what they would want (or not want) them to be like as a scientists. The differing format used for each gender reflects an underlying assumption, held by the researchers, that females would not be able to think of themselves as scientists.

Appendix

Appendix – *Measurement Matters Survey Items*

When I think about scientists, I think that they:	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
1. Value recognition fame	1	2	3	4	5	6
2. Design experiments	1	2	3	4	5	6
3. Work on a computer	1	2	3	4	5	6
4. Work obsessively	1	2	3	4	5	6
5. Work regular hours	1	2	3	4	5	6
6. Have fun with colleagues at work	1	2	3	4	5	6
7. Maintain friendships with colleagues in other departments	1	2	3	4	5	6
8. Have lots of money and other resources	1	2	3	4	5	6
9. Know a lot about the latest discoveries	1	2	3	4	5	6
10. Do not have a lot of friends	1	2	3	4	5	6
11. Know a lot about popular culture	1	2	3	4	5	6
12. Enjoy their work	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
13. Neglect their family life	1	2	3	4	5	6
14. Are out of touch with what is happening in the world	1	2	3	4	5	6
15. Act with integrity/have a lot of integrity	1	2	3	4	5	6
16. Are the ones who know how equipment works	1	2	3	4	5	6
17. Are the ones who fix equipment that is broken	1	2	3	4	5	6
18. Are careful with expensive instruments	1	2	3	4	5	6
19. Depend on others to keep the equipment repaired	1	2	3	4	5	6
20. Depend on others to use equipment	1	2	3	4	5	6
21. Teach others about the equipment	1	2	3	4	5	6
22. Have happy marriages	1	2	3	4	5	6

When I think about scientists, I think that they are:	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
23. Self-sacrificing	1	2	3	4	5	6
24. Good communicators	1	2	3	4	5	6
25. Competitive	1	2	3	4	5	6
26. Cooperative	1	2	3	4	5	6
27. Independent	1	2	3	4	5	6
28. Caregivers	1	2	3	4	5	6
29. Rational	1	2	3	4	5	6
30. Emotional	1	2	3	4	5	6
31. Work Oriented	1	2	3	4	5	6
32. Family Oriented	1	2	3	4	5	6
33. Technically competent	1	2	3	4	5	6
34. Technically incompetent	1	2	3	4	5	6
35. Creative	1	2	3	4	5	6
36. Well educated	1	2	3	4	5	6
37. Out of touch with popular culture	1	2	3	4	5	6
38. Organized	1	2	3	4	5	6
39. Disorganized	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
40. Money oriented	1	2	3	4	5	6
41. Competent	1	2	3	4	5	6
42. Humble	1	2	3	4	5	6
43. Self-confident	1	2	3	4	5	6
44. Argumentative	1	2	3	4	5	6
45. Insecure	1	2	3	4	5	6
46. Collaborative	1	2	3	4	5	6
47. Active socially	1	2	3	4	5	6
48. Absent minded	1	2	3	4	5	6
49. Highly focused	1	2	3	4	5	6
50. Effective teachers	1	2	3	4	5	6
51. Able to learn to use new equipment quickly	1	2	3	4	5	6
52. Especially intelligent	1	2	3	4	5	6
53. Logical	1	2	3	4	5	6
54. Effective leaders	1	2	3	4	5	6
55. Clueless about popular culture	1	2	3	4	5	6
56. Honest	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
57. “Hip” or “Cool”	1	2	3	4	5	6
When I think about myself, I:	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
58. Value recognition fame	1	2	3	4	5	6
59. Design experiments	1	2	3	4	5	6
60. Work on a computer	1	2	3	4	5	6
61. Work obsessively	1	2	3	4	5	6
62. Work regular hours	1	2	3	4	5	6
63. Have fun with colleagues at work	1	2	3	4	5	6
64. Maintain friendships with colleagues in other departments	1	2	3	4	5	6
65. Have lots of money and other resources	1	2	3	4	5	6
66. Know a lot about the latest discoveries	1	2	3	4	5	6
67. Do not have a lot of friends	1	2	3	4	5	6
68. Know a lot about popular culture	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
69. Enjoy my work	1	2	3	4	5	6
70. Neglect my family life	1	2	3	4	5	6
71. Am out of touch with what is happening in the world	1	2	3	4	5	6
72. Act with integrity/have a lot of integrity	1	2	3	4	5	6
73. Know how equipment works	1	2	3	4	5	6
74. Am the one who fixes something that is broken	1	2	3	4	5	6
75. Am careful with expensive instruments	1	2	3	4	5	6
76. Depend on others to keep the equipment repaired	1	2	3	4	5	6
77. Depend on others to use equipment	1	2	3	4	5	6
78. Teach others about the equipment	1	2	3	4	5	6

When I think about myself, I am:	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
79. Self-sacrificing	1	2	3	4	5	6
80. A good communicator	1	2	3	4	5	6
81. Competitive	1	2	3	4	5	6
82. Cooperative	1	2	3	4	5	6
83. Independent	1	2	3	4	5	6
84. A caregiver	1	2	3	4	5	6
85. Rational	1	2	3	4	5	6
86. Emotional	1	2	3	4	5	6
87. Work Oriented	1	2	3	4	5	6
88. Family Oriented	1	2	3	4	5	6
89. Technically competent	1	2	3	4	5	6
90. Technically incompetent	1	2	3	4	5	6
91. Creative	1	2	3	4	5	6
92. Well educated	1	2	3	4	5	6
93. Out of touch with popular culture	1	2	3	4	5	6
94. Organized	1	2	3	4	5	6
95. Disorganized	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
96. Money oriented	1	2	3	4	5	6
97. Competent	1	2	3	4	5	6
98. Humble	1	2	3	4	5	6
99. Self-confident	1	2	3	4	5	6
100. Argumentative	1	2	3	4	5	6
101. Insecure	1	2	3	4	5	6
102. Collaborative	1	2	3	4	5	6
103. Active socially	1	2	3	4	5	6
104. Absent minded	1	2	3	4	5	6
105. Highly focused	1	2	3	4	5	6
106. Effective teachers	1	2	3	4	5	6
107. Able to learn to use new equipment quickly	1	2	3	4	5	6
108. Especially intelligent	1	2	3	4	5	6
109. Logical	1	2	3	4	5	6
110. Effective leaders	1	2	3	4	5	6
111. Clueless about popular culture	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
112. Honest	1	2	3	4	5	6
113. “Hip” or “Cool”	1	2	3	4	5	6
Survey section 2 (Perceptions of equal opportunities in science)	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
114. Women and men are equally smart at math	1	2	3	4	5	6
115. Women and men should have equally successful science careers	1	2	3	4	5	6
116. Women and men do have equally successful science careers	1	2	3	4	5	6
117. Women and men should receive equal educational opportunities in science	1	2	3	4	5	6
118. Women and men do receive equal educational opportunities in science	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
119. Women and men should receive equal employment opportunities in science	1	2	3	4	5	6
120. Women and men do receive equal employment opportunities in science	1	2	3	4	5	6
121. People of all ethnic groups are equally smart at math	1	2	3	4	5	6
122. People of all ethnic groups should have equally successful science careers	1	2	3	4	5	6
123. People of all ethnic groups do have equally successful science careers	1	2	3	4	5	6
124. People of all ethnic groups should receive equal educational opportunities in science	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
125. People of all ethnic groups do receive equal educational opportunities in science	1	2	3	4	5	6
126. People of all ethnic groups should receive equal employment opportunities in science	1	2	3	4	5	6
127. People of all ethnic groups do receive equal employment opportunities in science	1	2	3	4	5	6
128. Me gender should be an asset for a career in science	1	2	3	4	5	6
129. Me gender is an asset for a career in science	1	2	3	4	5	6
130. My ethnic background should be an asset for a career in science	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
131. My ethnic background is an asset for a career in science	1	2	3	4	5	6
132. A strong sense of belonging to an ethnic group should be important in science	1	2	3	4	5	6
133. A strong sense of belonging to an ethnic group is important in science	1	2	3	4	5	6
134. Working with people of different ethnic groups should be important in science	1	2	3	4	5	6
135. Working with people of different ethnic groups is important in science	1	2	3	4	5	6
136. In my ethnic group, men and women should have the same educational and employment opportunities in science	1	2	3	4	5	6

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
137. In my ethnic group, men and women do have the same educational and employment opportunities in science	1	2	3	4	5	6

Table 1

Women as a Percentage of all Bachelor's Degree Recipients, by Field: 1966-2006

	1966	1976	1986	1996	2006
Total Science and Engineering	16.1	22.2	32.4	35.3	38.6
Engineering	0.4	3.4	14.5	17.9	19.5
Science					
Earth, Atmospheric and Ocean Sciences	9.4	18.3	22.3	33.3	41.2
Biological/Agricultural Sciences	25.0	31.2	45.5	50.2	59.8
Physical Sciences	14.0	19.5	29.8	37.0	42.4
Mathematics	33.3	40.7	46.5	45.8	44.9
Computer Science	14.6	19.8	35.8	27.6	20.5

Note. Adapted from "Women, Minorities and Persons with Disabilities in Science and Engineering: 2000. Appendix Table 2-6. Women as a Percentage of all Bachelor's Degree Recipients, by Field: 1966-1996," by National Science Foundation, (2000a). Retrieved on November 11, 2008 from http://www.nsf.gov/statistics/nsf00327/append/c2/at02-06.pdf. "Women, Minorities and Persons with Disabilities in Science and Engineering:2004. Bachelor's degrees, by sex and field: 1995-2004," by National Science Foundation, (2004a).. Retrieved on October 1, 2007 from http://www.nsf.gov/statistics/nsf07308/pdf/tab4.pdf. "Women, Minorities and Persons with Disabilities in Science and Engineering. Bachelor's degrees by sex and field: 1997-2006," by National Science Foundation, (2009a). Retrieved on March 21, 2009 from http://www.nsf.gov/statistics/wmpd/sex.cfm#degrees.

Table 2

Percentage of Bachelor's Degrees in Science and Engineering, by Field, Citizenship, and Race/Ethnicity: 1989-2006

	1989	1994	2000	2006
European American, non-Hispanics				
Total Science and Engineering	76.4	73.2	67.7	64.8
Engineering	74.8	71.0	65.6	63.9
Science				
Earth, Atmospheric and Ocean Sciences	*	*	88.0	84.2
Biological/Agricultural Sciences	79.5	76.0	71.6	67.4
Physical Sciences	82.2	78.9	69.3	67.2
Mathematics	80.2	76.8	71.5	68.4
Computer Science	70.1	64.7	58.1	56.6
Asians/Pacific Islanders				
Total Science and Engineering	7.6	9.1	11.0	11.3
Engineering	9.1	10.4	11.5	12.5
Science				
Earth, Atmospheric and Ocean Sciences	*	*	2.4	2.4
Biological/Agricultural Sciences	6.7	9.4	10.2	11.8

(continued)

Table 2 (continued)

	1989	1994	2000	2006
Physical Sciences	5.3	5.9	10.0	9.9
Mathematics	6.7	6.4	7.6	9.4
Computer Science	7.3	9.2	14.5	10.2
African American, non-Hispanics				
Total Science and Engineering	4.6	5.5	6.6	6.6
Engineering	3.1	4.2	5.1	4.7
Science				
Earth, Atmospheric and Ocean Sciences	*	*	1.3	1.5
Biological/Agricultural Sciences	4.5	5.0	6.2	6.5
Physical Sciences	4.0	5.0	7.5	6.3
Mathematics	5.2	6.9	7.7	5.5
Computer Science	7.9	9.8	9.4	10.8
Hispanics				
Total Science and Engineering	4.0	4.7	6.1	6.5
Engineering	3.8	5.0	6.8	7.2
Science				
Earth, Atmospheric and Ocean Sciences	*	*	3.1	3.6

(continued)

Table 2 (continued)

	1989	1994	2000	2006
Biological/Agricultural Sciences	5.0	5.0	6.1	6.3
Physical Sciences	3.3	4.0	6.1	6.0
Mathematics	2.4	3.8	5.1	5.7
Computer Science	3.9	4.6	5.8	6.7
American Indians/Alaskan Natives				
Total Science and Engineering	0.3	0.4	0.8	0.6
Engineering	0.3	0.4	0.6	0.5
Science				
Earth, Atmospheric and Ocean Sciences	*	*	1.1	0.9
Biological/Agricultural Sciences	0.4	0.5	0.7	0.7
Physical Sciences	0.4	0.5	0.5	0.6
Mathematics	0.4	0.4	0.6	0.4
Computer Science	0.3	0.3	0.5	0.5
U.S. Citizens and permanent residents, unknown race/ethnicity				
Total Science and Engineering	1.8	2.0	3.2	5.3
Engineering	1.4	1.9	2.7	4.3

(continued)

Table 2 (continued)

	1989	1994	2000	2006
Science				
Earth, Atmospheric and Ocean Sciences	*	*	3.0	5.6
Biological/Agricultural Sciences	1.5	2.0	3.2	4.6
Physical Sciences	1.4	2.0	3.1	5.3
Mathematics	1.6	1.8	3.4	5.3
Computer Science	3.6	2.1	4.2	8.4
Nonresident aliens				
Total Science and Engineering	5.4	5.1	4.8	4.9
Engineering	7.6	7.2	7.6	7.0
Science				
Earth, Atmospheric and Ocean Sciences	*	*	1.1	1.9
Biological/Agricultural Sciences	2.5	2.1	2.0	2.6
Physical Sciences	3.5	3.9	3.7	4.7
Mathematics	3.6	3.9	4.1	5.3
Computer Science	6.9	9.3	7.7	6.8

Note. Adapted from “Women, Minorities and Persons with Disabilities in Science and Engineering: 2000. Appendix Table 2-8. Bachelor’s Degrees in Science and Engineering, by Field, Citizenship, and Race/Ethnicity: 1989-96,” by National Science Foundation, (2000b). Retrieved on November 11, 2008 from

http://www.nsf.gov/statistics/nsf00327/append/c2/at02-08.pdf. “Women, Minorities and Persons with Disabilities in Science and Engineering:2004. Bachelor’s degrees, by field, citizenship, and race/ethnicity: 1995-2004,” by National Science Foundation, (2004b). Retrieved on October 1, 2007 from http://www.nsf.gov/statistics/wmpd/pdf/tabc-5.pdf. “Women, Minorities and Persons with Disabilities in Science and Engineering. Bachelor’s Degrees, by field, citizenship and race/ethnicity: 1997-2006,” by National Science Foundation, (2009b). Retrieved on March 21, 2009 from http://www.nsf.gov/statistics/wmpd/race.cfm#degrees.
* No data recorded for this year.

Table 3

Sample Size of Participants by Major (STEM or non-STEM) including Gender and Ethnicity

	STEM	Non-STEM
Females	374	192
Males	231	126
European American	467	262
Non-European American	145	61
European American Females	286	158
European American Males	180	103
Non-European American Females	88	34
Non-European American Males	51	23
Total n	612	323

Note. For the purposes of analysis in this study ethnicity was grouped into two categories.

Table 4

Exploratory Factor Analysis Results for Stereotypes of Scientists

Item	Mean	Factor Loading: Professional Competencies	Factor Loading: Interpersonal Competencies
52. Especially intelligent	4.68	.65	-.08
49. Highly focused	4.95	.64	.02
51. Able to lean to use new equipment quickly	4.38	.61	-.01
33. Technically competent	4.83	.58	.08
31. Work oriented	4.85	.54	-.16
16. Are the ones who know how equipment works	4.48	.53	-.09
41. Competent	4.90	.49	.23
53. Logical	4.79	.48	.14
27. Independent	4.59	.44	-.09
18. Are careful with expensive instruments	4.95	.44	.17

(continued)

Table 4 (continued)

Item	Mean	Factor Loading: Professional Competencies	Factor Loading: Interpersonal Competencies
9. Know a lot about the latest discoveries	4.77	.43	-.07
7. Maintain friendships with colleagues in other departments	4.53	-.12	.72
6. Have fun with colleagues at work	4.32	-.16	.71
10. Do not have a lot of friends	2.55	.11	-.69
32. Family oriented	3.99	.02	.61
26. Cooperative	4.47	.19	.47
46. Collaborative	4.51	.22	.41
Variance explained (Total = %)	33.71	23.39	10.32
Cronbach's Alpha		.82	.68
Number of items (Total = 17 items)		11	6

Note. N = 909. The SPSS default of listwise deletion was used.

Table 5

Multivariate Analysis of Being a STEM or Non-STEM Major by Gender, Ethnicity, SSS Score (Odds Ratios)

Predictor variable	Wald	Odds Ratio (Exp[B])
Gender (women vs. men)	0.47	1.11
Ethnicity (non-European American vs. European American)	6.00	1.56*
Scientist Self Similarity	29.81	0.36*

*$p < .05$.

Table 6

Multivariate Analysis of Being a STEM or Non-STEM Major by Gender, Ethnicity, SSS Score and their Interactions (Odds Ratios)

Predictor variable	Wald	STEM major
Gender (women vs. men)	7.03	2.95*
Ethnicity (non-European American vs. European American)	0.76	1.83
Scientist Self Similarity	0.76	0.76
Gender x SSS	7.21	0.30*
Ethnicity x SSS	0.26	0.71
Gender x ethnicity	0.01	1.11
Gender x ethnicity x SSS	0.05	1.22

*$p < .05$.

Table 7

Exploratory Factor Analysis Results for Perceptions of Equal Opportunities in Science

		Factor Loading	
Item	Mean	Should be Happening	Is Happening
152. People of all ethnic groups should receive equal employment opportunities in science	5.43	.83	.03
150. People of all ethnic groups should receive equal educational opportunities in science	5.44	.83	-.02
143. Women and men should receive equal employment opportunities in science	5.51	.79	-.00
145. Women and men should receive equal employment opportunities in science	5.47	.75	-.01

(continued)

Table 7 (continued)

Item	Mean	Factor Loading	
		Should be Happening	Is Happening
148. People of all ethnic groups should have equally successful science careers	5.25	.72	.06
141. Women and men should have equally successful science careers	5.26	.66	.04
162. In my ethnic group, men and women should have the same educational and employment opportunities in science	5.19	.65	-.05
153. People of all ethnic groups do receive equal employment opportunities in science	3.63	-.14	.88

(continued)

Table 7 (continued)

Item	Mean	Factor Loading: Should be Happening	Factor Loading: Is Happening
151. People of all ethnic groups do receive equal educational opportunities in science	3.75	-.05	.81
146. Women and men do receive equal employment opportunities in science	3.88	-.01	.81
149. People of all ethnic groups do have equally successful science careers	3.74	-.01	.77
144. Women and men do receive equal educational opportunities in science	4.36	.10	.74

(continued)

Table 7 (continued)

Item	Mean	Factor Loading: Should be Happening	Factor Loading: Is Happening
142. Women and men do have equally successful science careers	3.81	.09	.62
163. In my ethnic group, men and women do have the same educational and employment opportunities in science	3.98	.08	.60
Variance explained (Total = %)	56.82	32.52	24.31
Cronbach's Alpha		.89	.90
Number of items (Total = 14 items)		7	7

Note. N = 893. The SPSS default of listwise deletion was used.

Table 8

Multivariate Analysis of Being a STEM or Non-STEM Major by Gender, Ethnicity, and CV Score (Odds Ratios)

Predictor variable	Wald	Odds Ratio (Exp[B])
Gender (women vs. men)	1.18	1.18
Ethnicity (non-European American vs. European American)	4.52	1.46*
Critical Vision Score	5.60	0.86*

*p < .05.

Table 9

Multivariate Analysis of Being a STEM or Non-STEM Major by Gender, Ethnicity, CV Score and their Interactions (Odds Ratios)

Predictor variable	Wald	Odds Ratio (Exp[B])
Gender (women vs. men)	1.16	1.33
Ethnicity (non-European American vs. European American)	6.02	3.66*
Critical Vision Score	0.00	1.00
Gender x CV	0.70	0.87
Ethnicity x CV	5.24	0.52*
Gender x ethnicity	1.99	0.38
Gender x ethnicity x CV	7.91	2.01*

*$p < .05$.

Table 10

Probability of Being a STEM major by Gender and SSS score

		1 SD below		1 SD above
Variable	N	Mean SSS	Mean SSS	Mean SSS
Females	566	0.76	0.65	0.51
Males	357	0.66	0.63	0.61

Table 11

Probability of Being a STEM Major by Gender, Ethnicity, and CV Score

		1 SD below		1 SD above
Variable	N	Mean SSS	Mean SSS	Mean SSS
Non-European American Females	122	0.92	0.96	0.98
Non-European American Males	74	0.86	0.86	0.86
European American Females	444	0.75	0.87	0.94
European American Males	283	0.64	0.63	0.63

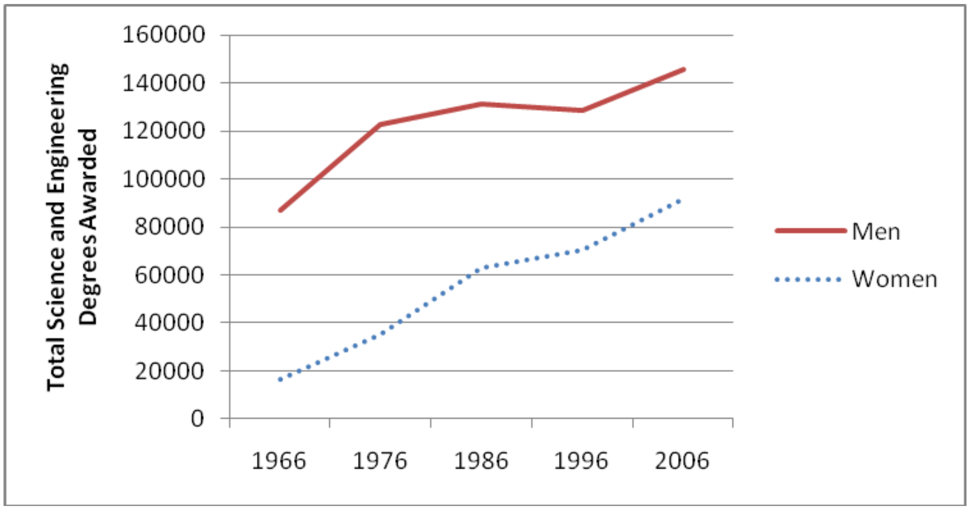

Figure 1. Total science and engineering degrees awarded by gender: 1966-2006

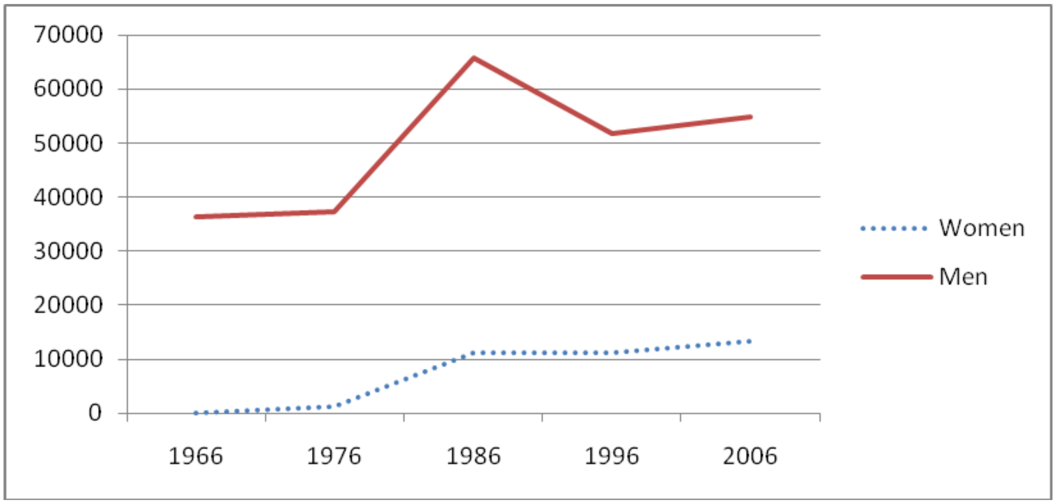

Figure 2. Engineering degrees awarded by gender: 1966-2006

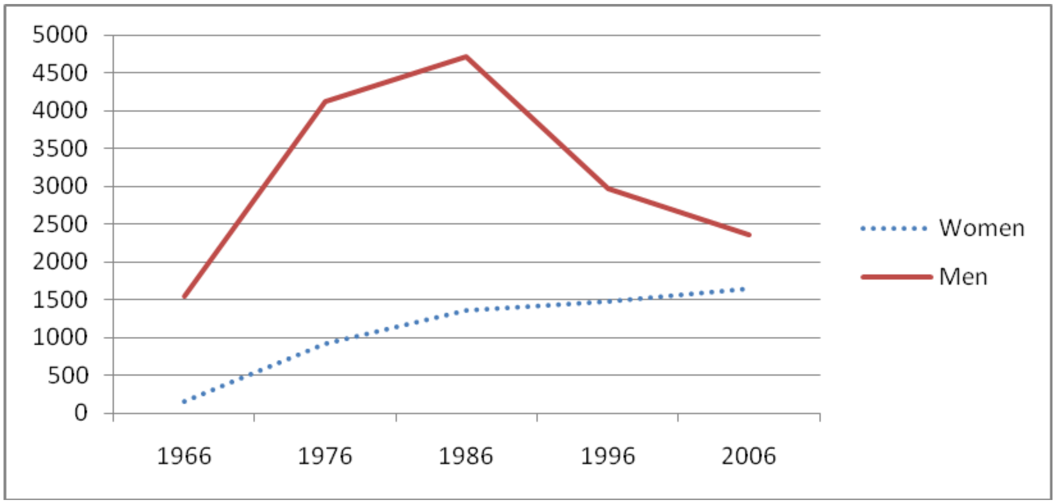

Figure 3. Earth, atmospheric, and ocean sciences degrees awarded by gender: 1966-2006

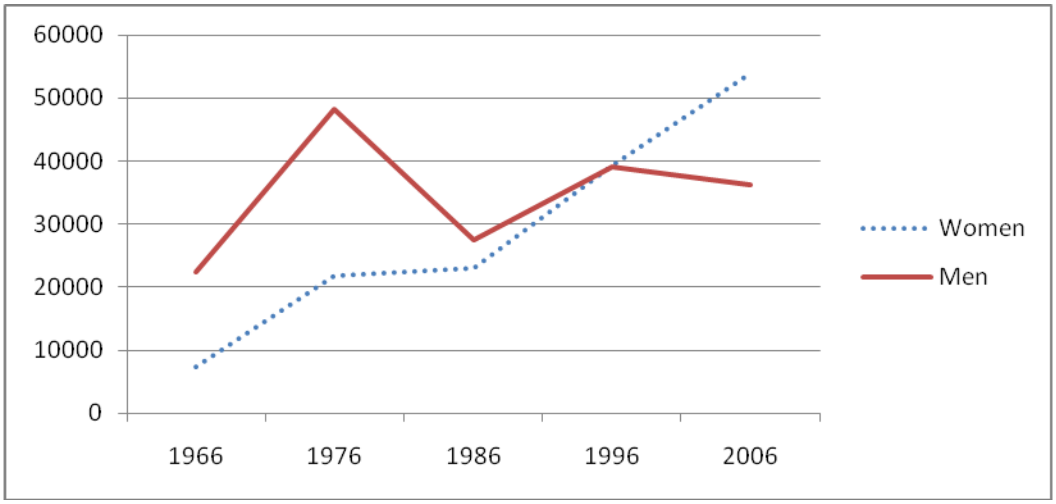

Figure 4. Biological/agricultural sciences degrees awarded by gender: 1966-2006

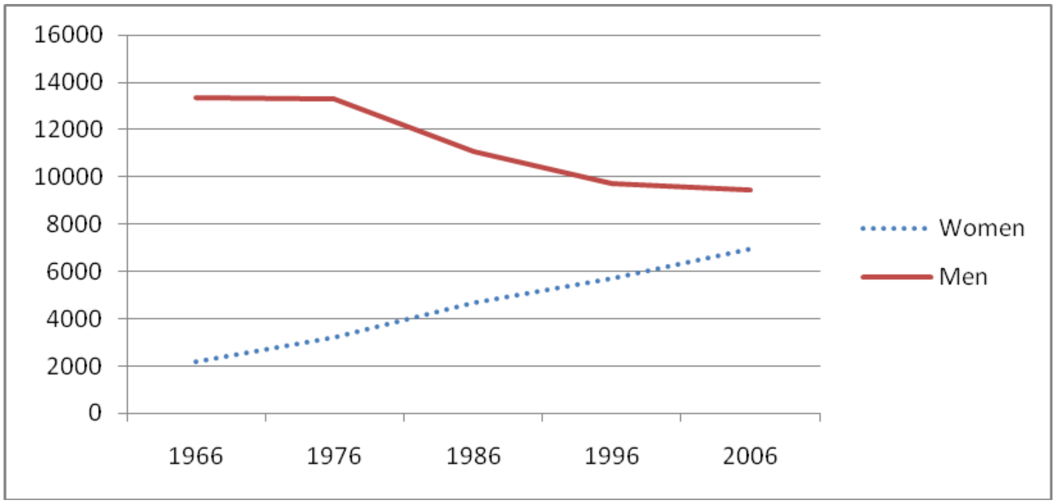

Figure 5. Physical sciences degrees awarded by gender: 1966-2006

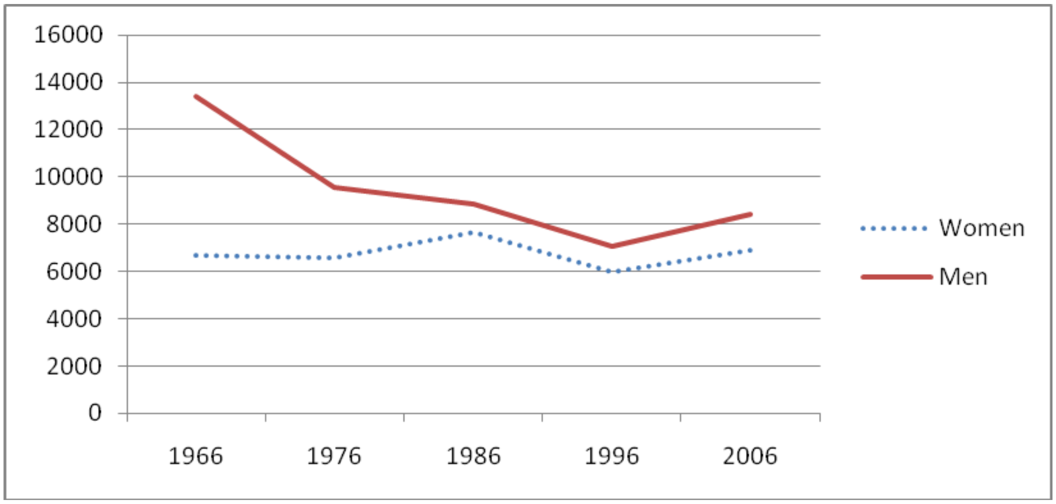

Figure 6. Mathematics degrees awarded by gender: 1966-2006

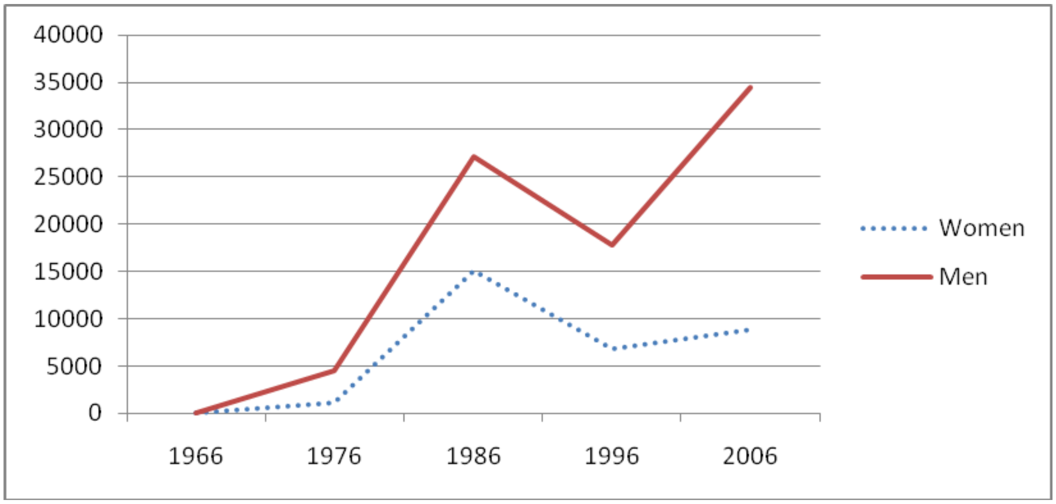

Figure 7. Computer science degrees awarded by gender: 1966-2006

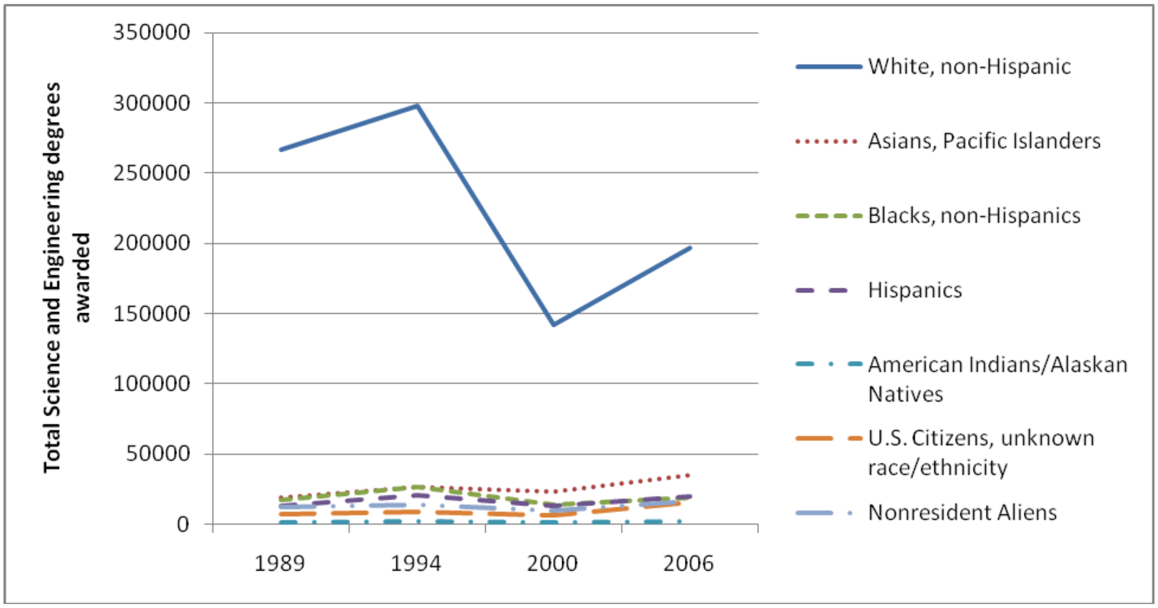

Figure 8. Total science and engineering degrees awarded by ethnicity: 1989-2006

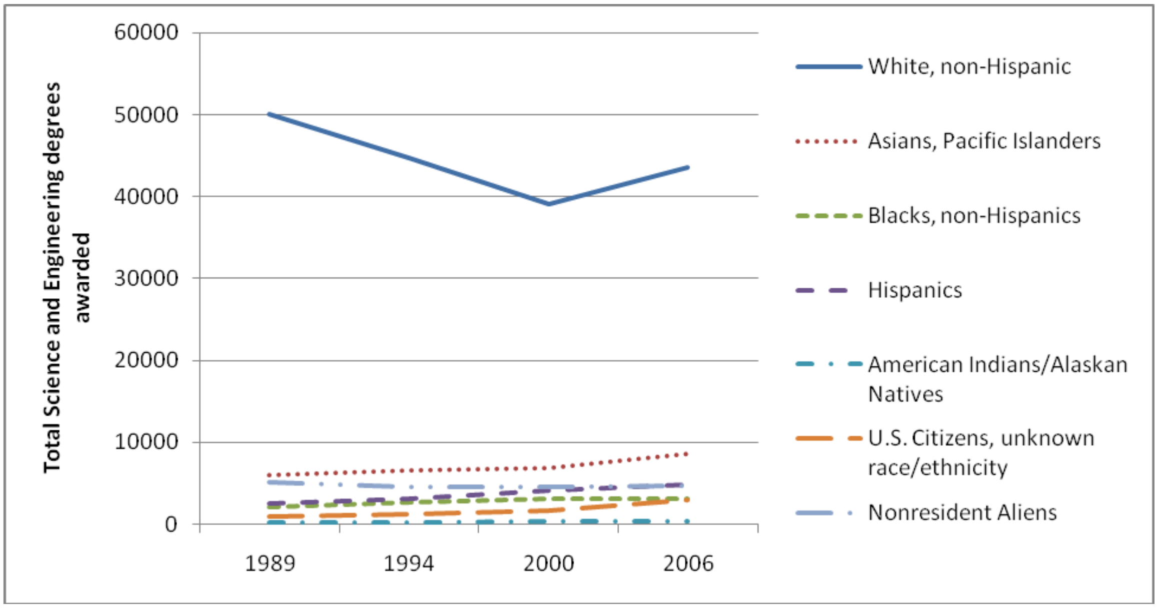

Figure 9. Engineering degrees awarded by ethnicity: 1989-2006

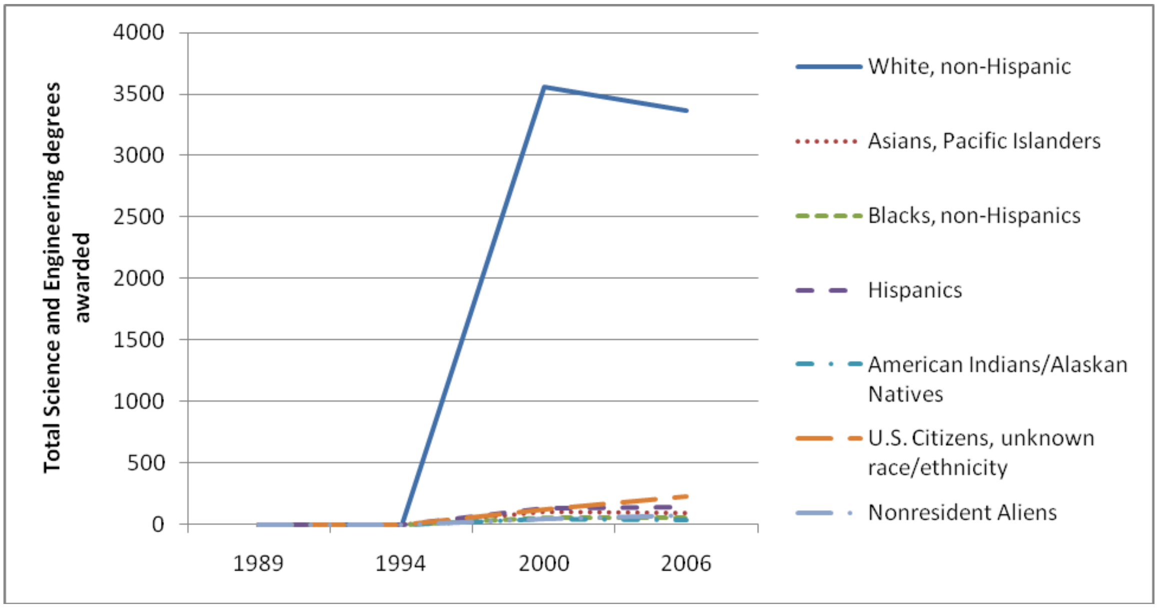

Figure 10. Earth, atmospheric, and ocean sciences degrees awarded by ethnicity: 1989-2006

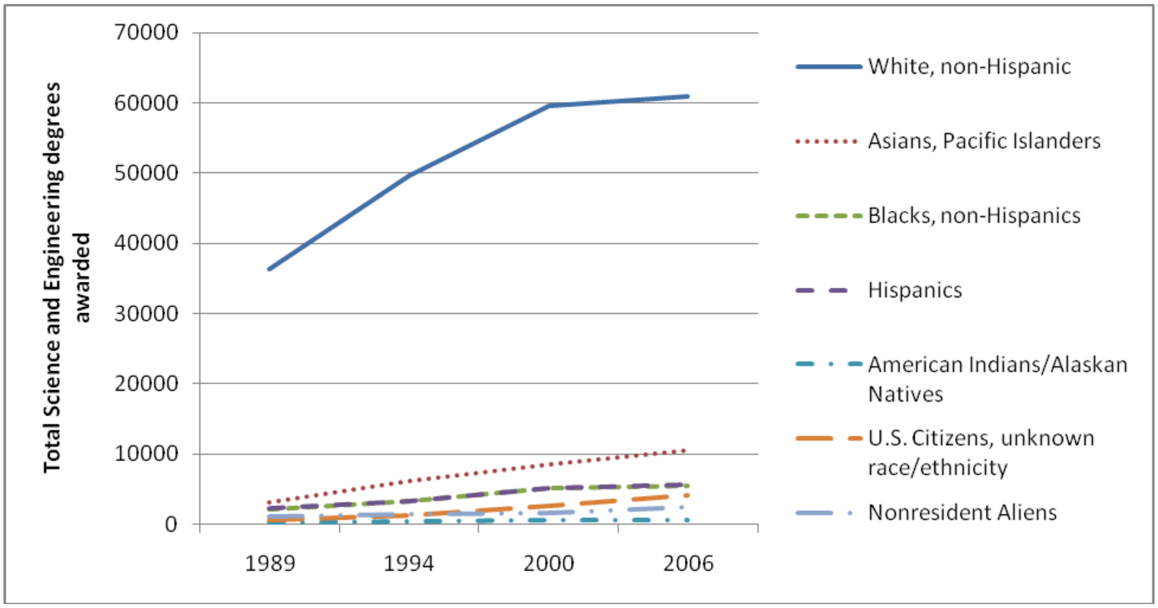

Figure 11. Biological/agricultural sciences degrees awarded by ethnicity: 1989-2006

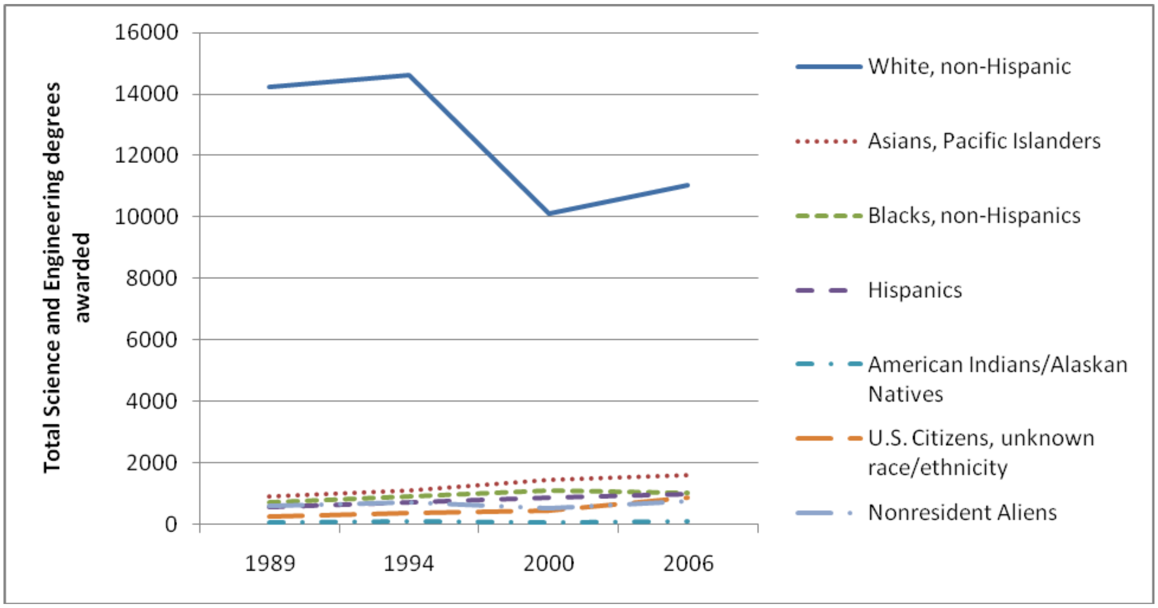

Figure 12. Physical sciences degrees awarded by ethnicity: 1989-2006

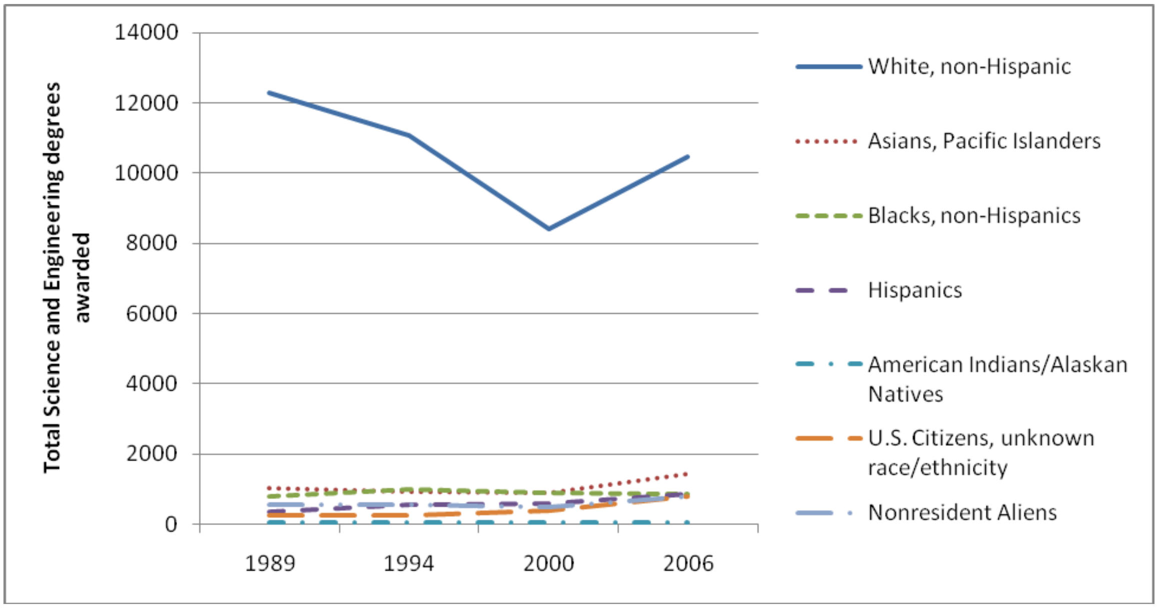

Figure 13. Mathematics degrees awarded by ethnicity: 1989-2006

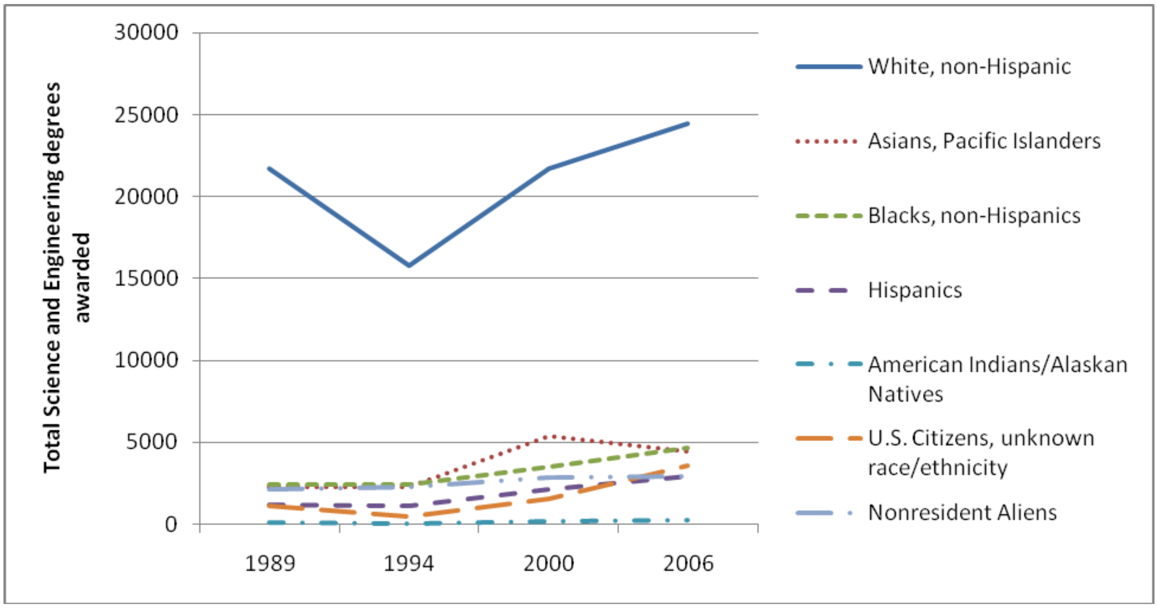

Figure 14. Computer science degrees awarded by ethnicity: 1989-2006

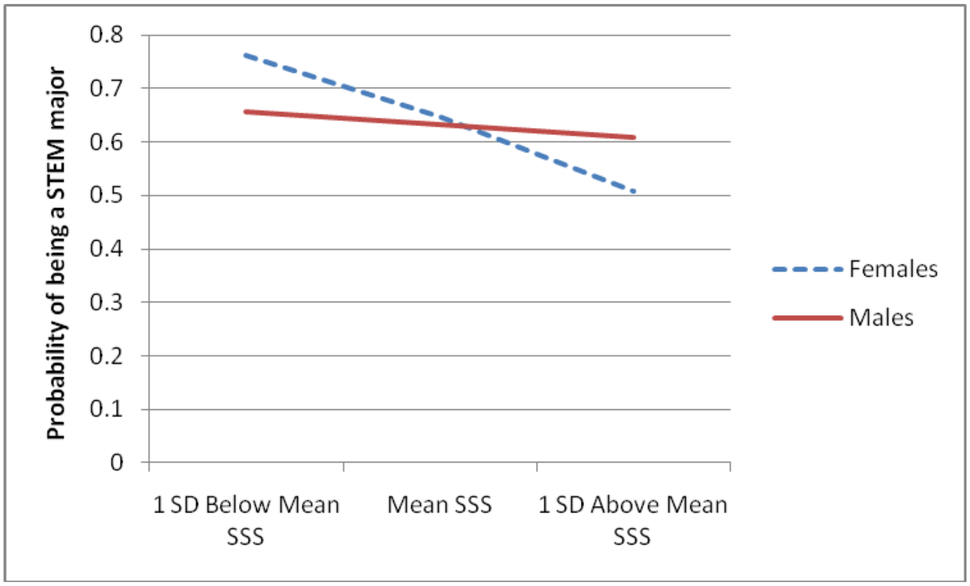

Figure 15. Probability of Being a STEM major by Gender and SSS score

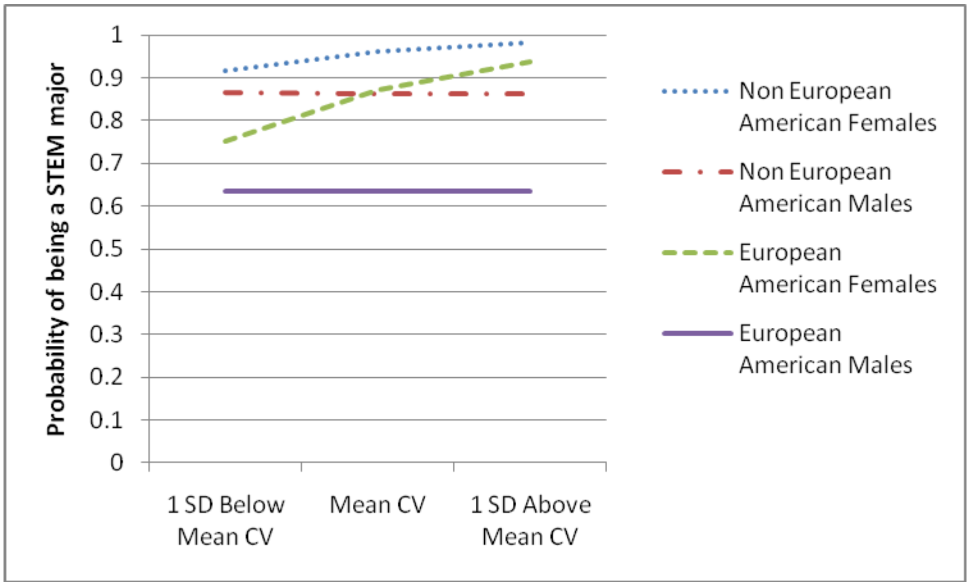

Figure 16. Probability of Being a STEM major by Gender, Ethnicity, and CV score