Interest and Success in STEM Disciplines for Women and Men across Ethnic and Socioeconomic Groups

Silvia Sara Canetto & David MacPhee

Gender and Ethnicity Representations in Elementary Science Materials

Theory and research suggest that cultural scripts of gender, ethnicity and science influence the gender and ethnic imbalances observed in the interest, participation, and achievement within the sciences. School science materials are likely a source of such scripts, particularly at the elementary level when students have little experience with science outside the classroom. The purpose of this study was to investigate the representation of female and male characters across ethnicities in elementary-school science materials.

Content coding of both science stories and illustrations showed that female characters were underrepresented in general as well as scientists. Female characters were depicted stereotypically with significantly fewer female characters overall, fewer pictures including a female character involved in a scientific activity, and fewer pictures accompanied by a description of female characters' work. There was relatively strong representation of ethnic groups in both science stories and illustrations, with the exception of Latinos.

The representation of women in elementary school materials might be a factor in children's perception that science is a gender-specific interest and talent, possibly contributing to females retreating from science education and careers.

Biasiolli, A., Hosoi, A. S., Winterrowd, E., Blumer, L., Conrad, S., Chan., E., & Canetto, S. S. (2008, August). *Before the leaky pipeline: Gender in elementary science book illustrations*. Poster presented at the annual meeting of the American Psychological Association, Boston, MA.

Bennett, J., Amundson, K., Chan, E., Biasiolli, A., Blumer, L., Canetto, S. S., & Hosoi, S. A. (2008, April). *The beginning of the leaky pipeline: Gender bias in elementary school science teaching materials*. Paper presented at the annual meeting of the Rocky Mountain Psychological Association, Boise, ID.

Farro, S. (2005). *Narratives of gender and technology in technology print advertisements* Unpublished Master's thesis, Colorado State University, Fort Collins, CO.

Farro, S., Canetto, S. & Ott, B. (2007, January). Cultural discourse regarding gender, ethnicity, and age: an analysis of computer print advertisements. In S. Canetto (Chair), *Gender, Culture and Science: Roadblocks and Solutions.* Invited Division 35 Symposium conducted at the National Multicultural Conference and Summit, The Psychology of Multiple Identities: Finding Empowerment in the Face of Oppression, Seattle, Washington.

Winterrowd, E., Canetto, S. S., Biasiolli, A., Mohajeri-Nelson, N., Hosoi, S. A., & Raymond, K. (August, 2009). *Depictions of ethnicity and gender in elementary school science materials.* Poster to be presented at the annual meeting of the American Psychological Association, Toronto, Canada.

Winterrowd, E., Raymond, K., Biasiolli, A., Hosoi, S., Bennell, S., Chan, E., & Canetto, S. S. (2009, January). *Gender and ethnicity in elementary science book stories*. Poster presented at the National Multicultural Conference and Summit, New Orleans, LA.

Academic Self-Perceptions and Performance of Gifted Female Science/Engineering Undergraduates

This study focused on high-achieving undergraduate STEM students from underrepresented ethnic and socioeconomic groups, upon admission to and graduation from the McNair Scholars Program. Students' self-perceived academic skills were compared to objective measures of their

academic performance. Women and men were similar in regard to objective academic performance. However, at Time 1, women were significantly more likely than men to describe themselves as academically weaker than their peers. Upon graduation from the McNair Program, women's self-perceptions of their academic skills were on par with those of their male peers. This suggests a positive influence of the McNair Program on women's self-perceived academic competence in the fields of science and engineering. Students with double minority status (i.e., by sex, ethnicity, generation in college, or income) had more negative self-perceptions of academic skills, as well as lower performance on standardized tests.

Overall, these findings suggest a positive influence of the McNair Program on women's perception of their academic competence. We speculate that the mentorship component of the program is especially beneficial. This study's findings also indicate that multiple minority status may have a cumulative negative impact on academic self-perceptions and academic performance.

Farro, S., MacPhee, D., Conrad. S., & Canetto, S. S. (2008, August). *Academic self-perceptions and performance of gifted science/engineering undergraduates.* Poster presented at the annual meeting of the American Psychological Association, Boston, MA.

Farro, S. (2009). *Achievements and challenges of undergraduates in science, technology, engineering, and mathematics fields in the Ronald E. McNair Program*. Unpublished doctoral dissertation, Colorado State University, Fort Collins, CO.

What Attracts High-Achieving, Socioeconomically Disadvantaged Students to Physical Sciences and Engineering?

Socioeconomically disadvantaged (SED) students are less likely to major in physical sciences or engineering. To guide recruitment and retention of a diversity of talent, two studies examined what attracts high-achieving SED students to these fields via an open-response survey. Participants were undergraduates majoring in physical sciences or engineering enrolled in the McNair Scholars Program. Interest in the process of discovery was a commonly reported theme for choosing to major in physical sciences or engineering. Another dominant and cross-cutting motivating factor was the goal to help people. Securing a good job also emerged as a theme, particularly for male and ethnic minority respondents. In one of the studies, timing of education and career decisions were later, future aspirations were less clear at graduation, commitment to goals was higher, and stress was higher for women in male-dominated fields (physical sciences and engineering) as compared to women in life sciences, where they were more equally represented.

These findings suggest that interventions to support women in all STEM education programs could benefit from including components such as assisting in career planning, fostering enjoyment of learning, providing information about job opportunities, connecting application of STEM to socially conscious and humanitarian issues, and providing career exploration opportunities.

Conrad, S. (2008).*What attracts McNair undergraduate students to physical sciences and engineering.* Unpublished Honor's thesis, Colorado State University, Fort Collins, CO.

Conrad, S., Canetto, S. S., MacPhee, D., & Farro, S. (2009). *What attracts high-achieving disadvantaged students to physical sciences and engineering?* Manuscript submitted for publication.

Farro, S., Canetto, S. S., & MacPhee, D. (2009). *Women in engineering, physical, and life sciences explain their educational choices*. Manuscript in progress.

Differential Attrition from Undergraduate Engineering Programs: Is it a Factor in the Underrepresentation of Women among Engineering Doctorates?

Increases in the proportion of women in engineering have been slow relative to other historically male-dominated careers. Higher attrition by women than men from graduate engineering programs has been proposed as an explanation, but few studies have tested this directly. Additionally, past research has not taken into account how differences in engineering field or the cultural background of students may affect enrollment and degree completion. This is an important omission, because women's representation varies widely depending on engineering field, and foreign nationals comprise over half of the doctoral students in engineering programs in the United States.

This study found that women's enrollment in graduate engineering programs showed no consistent pattern of change between 1990 and 2004. Term of first enrollment, final GPA, and marital status significantly affected degree completion, with these effects being the same for women and men. Importantly, women were equally as likely as men to complete a doctoral degree when the above factors were taken into account.

Overall, this study suggests that higher attrition by women may not be a factor in the low proportion of women earning engineering doctoral degrees. Women did not show consistent increases in enrollment over the past 15 years, suggesting that improved graduate school recruitment may be critical to increasing the number of doctoral-level female engineers.

Hosoi, S. A. (2006). *Differential attrition from graduate engineering programs: Is it a factor in the under-representation of women among engineering doctorates?* Unpublished Master's thesis, Colorado State University, Fort Collins, CO.

Hosoi, S.A., & Canetto, S. S. (2007, January). A longitudinal analysis of graduation rates of women and men in graduate engineering programs. In S. Canetto (Chair), *Gender, Culture and Science: Roadblocks and Solutions.* Invited Division 35 Symposium conducted at the National Multicultural Conference and Summit, The Psychology of Multiple Identities: Finding Empowerment in the Face of Oppression, Seattle, Washington.

Hosoi, S. A., & Canetto, S. S. (2009). *Differential attrition from undergraduate engineering programs: Is it a factor in the under-representation of women among engineering doctorates?* Manuscript submitted for publication.

Choice and Persistence in Atmospheric Science and Engineering Graduate Education

In the United States, the representation of women and certain ethnic minorities drops at increasingly higher levels of STEM education and careers. This is particularly the case in the Atmospheric and Geo Sciences. This study tracks the experiences of women and men in STEM fields from the undergraduate to the early postdoctoral years. Among the questions we are asking, using both surveys and semi-structured interviews, are:

- How do the aspirations and expectations of female and underrepresented ethnic minority scientists change as they progress from undergraduate to graduate studies to the post-doc years?
- What may be the unique resources that female and underrepresented ethnic minority students may bring to careers in sciences, as compared to males from well-represented ethnic groups?
- What are the unique challenges (personal, familial, financial, cultural) faced by female and underrepresented ethnic minority STEM students?
- What are the factors that lead to the decrease in the number of female and ethnic minority scientists at higher levels of STEM training and career?

- What is common and what is unique about ATS and Geo Science students, compared to other STEM students, with regard to the reasons for their choice and success in the field, as well as family and career issues?

Data have been collected from nearly 100 STEM undergraduate and graduate students at CSU and MIT. A case study based on intensive interviews with four ATS graduate students is being presented in a poster session at this meeting. Interviews with ATS and Geosciences students are continuing, with participants still being recruited from both CSU and MIT (in collaboration with Lodovica Illari, a faculty member in their Department of ATS and Geosciences). Data analysis for a study of career and family issues using a sample of CSU ATS graduate students is underway. A third study currently in progress examines questions about choice and persistence in STEM disciplines.

On a related note, we also are conducting a systematic literature review on strategies known to be effective at recruiting and retaining women and underrepresented ethnic minorities in ATS and its "feeder" majors, with the goals being to (a) identify where the "pipeline" is the leakiest, (2) provide benchmarks for evaluating the success in meeting Diversity Goals A and C in the CMMAP Strategic Plan, and (3) make recommendations for how to effectively recruit and retain a diversity of talent, as SOARS and some other programs do.

For grant renewal, we propose further analyses of the data collected during the first five years of the grant, based on the findings that are emerging, In addition, we propose to partner with SOARS in designing a study that examines the experience of SOARS participants.