Examining the Quality of Cross-Sex Interactions in Undergraduate STEM Courses and How it Affects Women's Belonging, Self-Efficacy, and Confidence in STEM

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1. Goals and Objectives

The goal of this research is to examine environmental factors that increase women's intentions to persist in STEM fields. We intend to achieve this goal by addressing two important research questions, (1) what is the quality of interactions between male and female undergraduates (i.e., cross-sex contact) in male-dominated Science, Technology, Engineering, and Math (STEM) fields? And (2) how does the quality of women's cross-sex contact relate to their belonging, self-efficacy, and confidence in their abilities in STEM?

This research employs a social psychological perspective with a particular emphasis on the power of social norms in our environment to influence our personal convictions and behavior. The social psychological literature suggests that the social climate in STEM courses may make women feel unwelcome and less likely to persist in these fields (Good, Rattan, & Dweck, 2012; Yoshida, Peach, Zanna, & Spencer, 2012). Current research indicates that women's belonging, self-efficacy and confidence are important predictors of their intent to persist in STEM fields (Correll, 2001; Good et al., 2012; Marra, Rodgers, Shen, & Bogue, 2009). We hypothesize that high quality cross-sex contact is a powerful means to cultivate a positive social climate that will promote women's retention in male-dominated STEM majors by enhancing women's belonging, self-efficacy, and confidence in these fields.

2. Motivation and Previous Work

STEM courses often include a group project or other small group learning activity. Previous research has shown that interactive techniques such as small group activities are more effective in promoting student learning in STEM courses compared to traditional lectures (Deslauriers, Schelew, & Wieman, 2011; Prince, 2004). Furthermore, The Accreditation Board for Engineering and Technology requires the ability to collaborate in teams as a student outcome in their accreditation checklist (ABET, 2015 - 2016).

Social cohesion (i.e., the extent to which members enjoy being in the group, and feel that they belong) enhances group members' ability to work interdependently (Chang & Bordia, 2001). Working interdependently allows the group to integrate different perspectives and develop a shared understanding, which are critical factors in effective group problem-solving (Van den Bossche, Gijselaers, & Segers, 2006). We anticipate that women will feel that they belong less in male-dominated groups as compared to in all female groups. In our own research, we have examined the consequences of being in an all-female versus a male-dominated collaborative problem-solving group for women's experience of social cohesion with their group members. Consistent with our theorizing, we found that women who were the only female in their group (male-dominated group) felt less belonging in the group than women in an all female group (Grover, Ito, & Park, In prep).

Given that women are underrepresented in many STEM fields, it may not be possible to assign them to work in an all female group in their STEM courses. Changing the dynamics of the group interaction could help women to feel a greater sense of belonging in male-dominated groups and provide a more plausible intervention than assigning women to work in all female groups. We draw on the intergroup contact literature to determine which factors will result in more positive interactions between female and male students. Over 60 years of research in social psychology has examined the essential criteria for positive intergroup contact (see Pettigrew, 1998 for a review). The essential criteria for positive intergroup contact include (1) a common goal (2) intergroup cooperation (3) equal status (4) the support of law, authorities, or custom, and (5) the potential for friendship to develop. For women in STEM courses, having cross-sex contact that meets these essential criteria (i.e., positive cross-sex contact) may bolster their sense of belonging in STEM as compared to women who have more negative cross-sex contact experiences in their STEM courses.

Positive cross-sex contact in the context of small group interactions may also enhance women's self-efficacy and confidence in their abilities in STEM. In particular, having equal status with male classmates, which is an essential criterion of positive intergroup contact, may enhance women's self-efficacy and confidence. Unfortunately, female students are not likely to be afforded the same roles as their male classmates in these small group interactions. Research by Linder, Sommerville, Eris, and Tartar (2010) found that female undergraduates in a project-based Engineering design course were less likely to complete "technical" tasks (i.e., modeling using CAD, and prototyping) and were more likely to complete "people-oriented" tasks (i.e., learning about people's needs, and preparing presentations) compared to their male classmates (Figure 1). To the extent that women's roles and contributions are restricted to non-technical tasks, they may have a lower sense of self-efficacy and confidence in their ability to fulfill these roles.

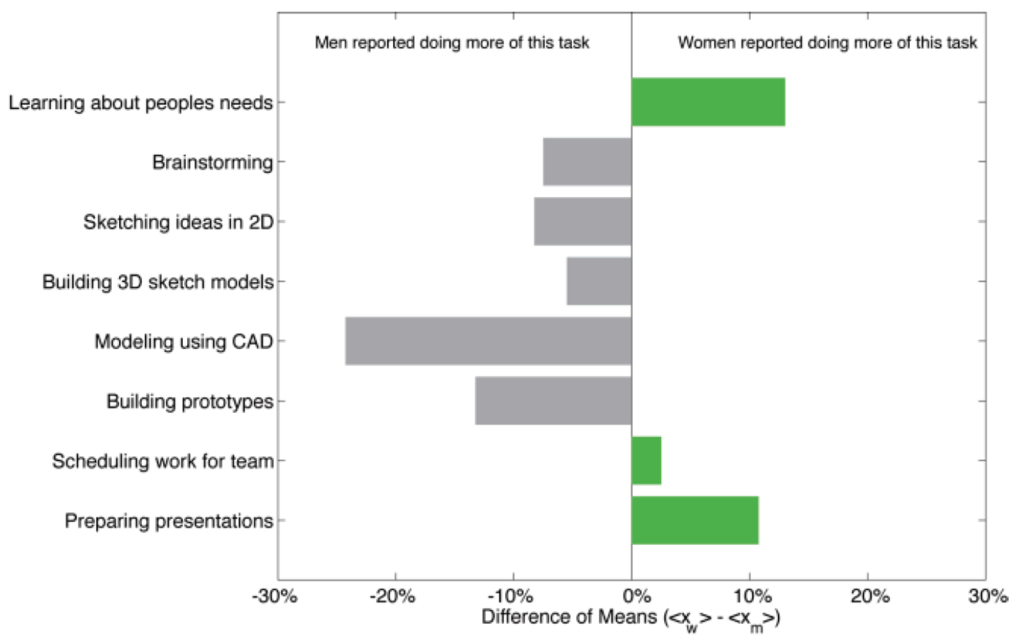

Figure 1. Gender Differences in Mean Reported Individual Activity Levels (taken from Linder et al., 2010)

4. Methodology

This research bears some similarity to research examining environmental factors that create a "Chilly Climate" for women in higher education (Hall & Sandler, 1982); however, it also has some important differences. First, we focus on male-dominated STEM fields because women are especially likely to experience a negative social climate due to the fact that they are underrepresented in these fields and must contend with ability-demeaning stereotypes. Second, whereas previous "Chilly Climate" research has primarily examined professor-student interactions we examine women's interactions with their male classmates, which are likely to be important for shaping perceptions of the social climate in STEM. Third, we use quantitative (as opposed to qualitative) methods to assess the quality of cross-sex contact in small group interactions in STEM. Implementing quantitative methods allows us to explicitly test the hypothesis that positive cross-sex contact bolsters women's belonging, self-efficacy, and confidence in STEM over time. Given that we are interested in factors that promote women's retention and success in male-dominated STEM fields, our sample of interest is incoming freshmen women who are majoring (or are intending to major) in a male-dominated STEM field.

Participants. At the beginning of Fall semester 2015, we will invite freshman female students enrolled in an introductory STEM course that incorporates interactive, small group learning activities to participate in our study. We have already identified several courses fitting this description. GEEN 1400, First-Year Engineering Projects is an interdisciplinary hands-on course for entry-level engineering students in which students work in teams to design, build, and test projects. The introductory Physics (PHYS 1110) and Calculus (APPM 1350) classes also frequently incorporate group work in their recitation sections. Students enrolled in APPM 1350 may also enroll in COEN 1350, which provides problem-solving assistance to students in a collaborative learning environment. Examining cross-sex contact in a variety of courses is beneficial because it allows us to examine variation in the frequency and type of collaborative activities and how this relates to positive cross-sex contact and will allow for a larger sample of women. We anticipate that most women in these courses intend to major in a male-dominated STEM field; however, we will ensure that participants in our sample meet eligibility criteria by asking for their intended major.

Study Design. To assess the longitudinal impacts of cross-sex contact quality, we will collect questionnaire measures at three time points: the first week of classes (baseline), eight weeks into classes (intermediate measures) and the last week of classes (final outcomes). During the first and last week of classes we will collect measures of important psychological factors associated with academic success including belonging, self-efficacy, confidence in abilities, identification, and intentions to persist in their STEM major. Five weeks into classes we will collect measures of the quantity and quality of cross-sex contact. We implement this longitudinal design because it will allow us to examine changes in belonging, self-efficacy, etc. over the course of the semester (from the first week to the last week) and most importantly, the extent to which changes in these factors can be explained by the quality of women's cross-sex contact experiences. My advisor, Dr. Tiffany Ito, has collected data from a sample of freshmen women at CU enrolled in introductory Calculus and Physics and found that their belonging tends to decline over the course of the semester. With this in mind, we hypothesize that women who experience higher quality cross-sex contact will experience less of a decline in belonging over the course of the semester compared with women who experience lower quality cross-sex contact (see Figure 2 for a graph of predicted results).

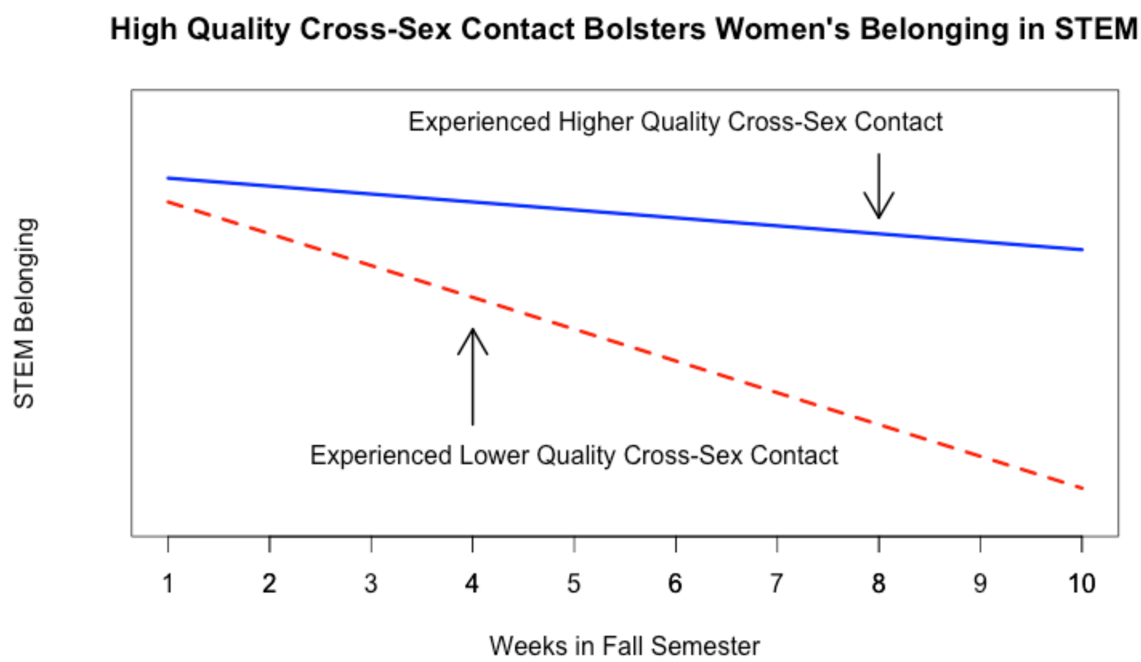

Figure 2. Predicted results for the effect of cross-sex contact quality on STEM belonging over time

Measures. Our two primary sets of measures are self-reports of cross-sex contact quality and psychological outcomes associated with academic success. For the measure of cross-sex contact quality, we intend to include measures of each criterion for positive intergroup contact. This will allow us to examine the effect of cross-sex contact quality on different psychological outcomes both globally and with respect to each individual criterion. It is possible that cross-sex contact meets some criteria (e.g., cooperation, common goal) more than others (e.g., equal status, potential for friendship). Measures and sample scale items are presented in Table 1.

5. Project Timeline

I will develop the questionnaire measures and submit all materials for IRB approval during Summer 2015. The questionnaire measures will be administered throughout Fall 2015, and analyzed at the end of the semester. In Spring 2015, I will complete data analysis and present the results at DBER in Spring 2016 and will also write up the results for publication.

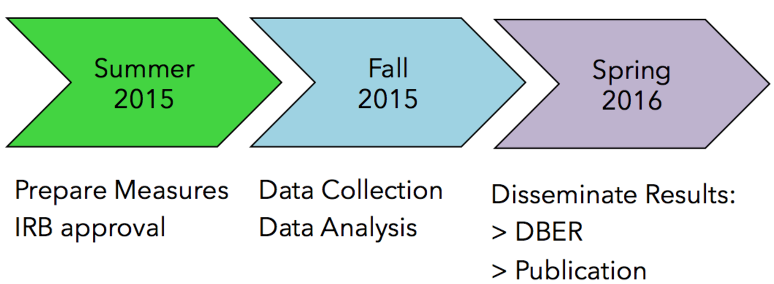

Figure 3. Project timeline

Table 1. Questionnaire Measures

Scale	**Sample Item**
1. Cross-Sex Contact Quality Measures	When working with your male classmates…
Common Goal	Do you feel like you are working towards the same goal?
Intergroup Cooperation	How much do you cooperate?
Equal Status	Do you feel like they acknowledge your contributions?
Support of Law, Authorities, or Custom	Do you feel like you are encouraged to work together?
Potential for Friendship	Do you feel like you could become friends?
2. Important Psychological Outcomes	
Belonging	I feel like I fit in with people in my major
Confidence in Abilities	I feel similar to the kinds of people who have what it takes to succeed in my major
Self-Efficacy	I can always manage to solve difficult problems if I try hard enough
Intentions to Persist	I could see myself going into a career related to my major

6. Project Outcomes

Personal Development. This project will provide the pilot data needed to develop my dissertation research. For my dissertation, I plan to test and develop an intervention to foster high quality cross-sex contact in male-dominated STEM courses, with the goal of creating a more inclusive environment for women. This research will provide important initial evidence for the hypothesis that high quality cross-sex contact bolsters women's belonging in male-dominated STEM fields over time. The results of the research will also help me to tailor my intervention to focus on criteria for positive cross-sex contact that are not already being met.

Home Department Benefits. The department of Psychology and Neuroscience will benefit from the connections formed with DBER group members and from the increased visibility of our research in the CU community. Consequently, this research may foster new collaborations between our department and other STEM departments on campus. This research could also help to bring in grant money by providing important preliminary data.

Benefits to the CU community. The CU community will benefit from this project as it will help to identify specific areas in which cross-sex contact quality in STEM courses can be improved. Once identified, the CU community may use this information to improve the social climate for women in male-dominated STEM fields and increase their retention rate.

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