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Perceptions of Ability, Work Ethic, and Participation in College STEM Classes

Amy Roberson Hayes[1], Kristin J. Hixson[2], Stephanie L. Masters[3]

[1]University of Texas at Tyler, [2]University of Nevada- Las Vegas, [3]University of Alabama, USA

ABSTRACT
Research has shown that female students consistently under-rate their performance and ability in STEM classes relative to their male peers, and that the converse is true for male students (Grunspan, Eddy, Brownell, Wiggins, Crowe & Goodreau, 2016). Our study examines the possible gender-differentiated experiences of students in college STEM courses. Participants included 192 U.S. undergraduate students (133 female, 59 male). Students completed an online survey which asked them to rate their experiences in their most recent college science, mathematics, and social science classes. Results showed that the grade students received in their most recent class was the variable most predictive of ability and work ethic perceptions across disciplines. There were no gender differences in course grades or perceptions of ability in math and science classes, although women ranked themselves significantly higher than men did in terms of work ethic across all three subject areas. Individual motivation factors such as mastery orientation were not related to perceptions of ability in any field but did predict students' perceptions of their work ethic. Finally, there were no effects of the gender composition of the course on students' perceptions of classroom experiences across disciplines. Our results showed that women and men judge their performance, ability, and effort relative to their peers differently even when they receive the same grade in a course.

KEYWORDS
college students, perceptions of ability, motivation, performance

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Women are increasingly represented among science, technology, engineering, and mathematics (STEM) fields at U.S. colleges and universities, especially in biological and social sciences (National Center for Education Statistics, 2018). For example, women earned 59% of bachelor's degrees in biology 2015 (National Science Foundation, 2018). In contrast, fewer than 20% of bachelor's degrees in computer science and engineering were awarded to women in in the same year (National Science Foundation, 2018). Despite decades of effort aimed at increasing women's representation in STEM fields, women remain stubbornly underrepresented in a subset of STEM disciplines. The underrepresentation of women in STEM fields that are specifically math-intensive, such as mathematics, computer science, and engineering, suggests that studying women's experiences in STEM as a monolith would be a broad oversimplification (Ceci, Ginther, Kahn, & Williams, 2014; Ceci & Williams, 2010). Thus, we wanted to examine the experiences of college students across a range of types of STEM classes: mathematics, science, and social science classes. We hoped that, by disaggregating the factors that affect classroom experiences in a diverse set of college courses, we could uncover some of the mechanisms that affect women's perceptions of their ability, effort, and participation in these traditionally male-dominated fields.

Confidence and Perceptions of Ability in STEM

Large-scale reviews of the literature surrounding sex differences (or lack thereof) in STEM have focused on reviewing four potential mechanisms to explain the disparity of women seen in the upper-most levels (e.g., professors, research scientists, industry leaders) of these fields: ability differences, work-value differences, interest differences, and differential experiences with discrimination (Ceci & Williams, 2010; Ceci, Williams, & Barnett, 2009). Evidence for innate gender differences in mathematics and science ability is scarce (Hyde, 2007; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Hyde & Linn, 2006). However, there is an abundance of evidence that sociocultural factors, such as the environmental forces that shape women's and men's choices of careers, hold more power in explaining the dearth of women at the top of STEM fields than do biological explanations (Ceci et al., 2009; Hayes & Bigler, 2013, 2015). In our paper, we specifically sought to examine the impact of classroom experiences in shaping students' perceptions of ability and work ethic in a range of STEM fields. Ability perceptions, whether accurate or inaccurate, have been shown to impact self-efficacy and persistence in a subject area or field (Wigfield & Eccles, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992).

Expectancy-value theory (e.g., Eccles 2011; Eccles & Wigfield, 1995) holds that motivation is comprised of expectancy beliefs (e.g., confidence) and value beliefs (e.g., interest). Self-confidence in one's ability in the subject matter is a factor that heavily influences persistence in a given field, and research has shown this is especially true for women in male-dominated fields like science and math (MacPhee, Farro, & Canetto, 2013). Individuals use several points of comparison to determine their ability in a given domain. Eccles (2009) suggests that an individual's self-efficacy in a domain develops through internal and external comparisons. Internally, students compare their own performance across domains to form an ability perception for a particular domain (Möller & Marsh, 2013). For instance, students may compare their abilities in a target domain (e.g., mathematics) with their achievement in another (e.g., English). Using an external frame of reference, individuals compare their own abilities to those of other people or groups (Festinger, 1954). However, there are gender differences and inaccuracies in students' self-comparisons in their STEM classes. Grunspan, Eddy, Brownell, Wiggins, Crowe, and Goodreau (2016) found that female students consistently under-rate their performance and ability in STEM classes relative to their male peers, and the converse is true for male students. Additionally, some research has shown that female students report lower STEM abilities compared to males even when they perform similarly in a course (Kiefer & Sekaquaptewa, 2007; Van Velsor, Taylor, & Leslie, 1993). When students perceive themselves to be lower in ability in STEM subjects than their peers, these beliefs negatively impact their self-efficacy and in turn can affect continuation in that field. In a study conducted by Wang and Degol (2013), higher levels of self-efficacy in a subject led to higher interest, achievement and continuation in STEM fields.

Individual Motivational Factors and Work Ethic

Another factor that has been hypothesized to affect women's persistence in STEM is the belief that success in science is the result of natural talent rather than an abundance of effort (Kiefer & Shih, 2006; Smith, Lewis, Hawthorne, & Hodges, 2012; Williams & King, 1980). Messages about who is intelligent and why begin at a young age. For example, parents tend to view girls' successes in math to be the result of effort, while boys' successes are more likely to be attributed to natural ability (Gunderson, Ramierez, Levine, & Beilock, 2012; Yee & Eccles, 1988). Youth are attuned to messages that associate intellectual ability with men rather than women and endorse gender-brilliant stereotypes (Bian, Leslie, & Cimpian, 2017). Given that math ability and brilliance are more frequently associated with men than women and are seen as prerequisites for success in STEM (e.g., Leslie, Cimpian, Meyer, & Freeland, 2015; Meyer, Cimpian, & Leslie, 2015), it is important to consider how perceived ability might influence gender differences in motivational beliefs. Indeed, beyond childhood, women's successes are frequently attributed to effort rather than ability (e.g., Raty, Vanska, Kasanen, & Karkkainen, 2002). Researchers have shown that different perceptions of effort (Heyman & Compton, 2006; Heyman et al., 2003), including perceptions of effort sources (Muenks, Miele, & Wigfield, 2016), influence students' interpretation of their achievement-related experiences. Indeed, a series of studies by Smith, Lewis, Hawthorne, and Hodges (2012) found that women in STEM fields perceived that they needed to expend more effort and work harder than their male peers in order to achieve the same level of success.

Seminal work by Nicholls (1984) and Dweck (1999) suggests that students view the relationship between effort and ability in two ways. Some students hold the belief that ability and effort are positively related, where high levels of effort are congruent with high levels of ability. Other students believe that their levels of effort and ability are inversely related, such that the harder an individual works to complete a task, the less ability they have. For example, in a study conducted by Nicholls and colleagues (1986), college students identified harder-working students as having less ability in the subject compared to students who seemed to put forth less effort. Relative to brilliance (Meyer et al., 2015), effort and dedication are typically viewed as being under one's control, which may level the playing field for women (e.g., Good, Aronson, & Inzlicht, 2003; Smith et al., 2012). Elliot and Church's (1997) model of achievement motivation and academic outcomes proposed that beliefs about ability and effort can translate into the goals that one has for achievement in academic settings. Importantly, they differentiated between the goal of doing well in a class in order to learn something (mastery orientation), the goal of doing well in order to outperform others in the class (performance-approach orientation), and the goal of avoiding public displays/tests of ability (performance-avoidance). In their original test of this model, Elliot and Church found that students' academic goals were related to both their intrinsic motivation in the subject matter and their graded performance. Importantly, students with the highest levels of performance-approach orientation tended to have higher grades but lower motivation than students with the other two types of motivation orientation. Additionally, students with mastery-orientation had the highest levels of intrinsic motivation to learn the material but were not different from other students in terms of their graded performance.

During periods of academic transition such as entry into college, individuals may be more susceptible to social cues that discredit their perceived ability to succeed in certain fields, perhaps contributing to the underrepresentation of women in STEM fields in higher education (Zeldin & Pajares, 2000). Women in STEM fields are particularly sensitive to situational cues that they may not fit in (Dasgupta, 2011). For example, women who are a numeric minority in math or science-related contexts feel a lower sense of belonging in those disciplines (Murphy, Steele, & Gross, 2007), which predicts lower enrollment in male-dominated math courses (Good, Rattan & Dweck, 2012). Contexts in which men outnumber women can implicitly suggest to women that they will have to invest more than their male counterparts to be successful in that domain (Smith et al., 2013). Given that success in some STEM fields is associated with natural ability, and women are more prone to the assumption that those who have to put forth large amounts of effort lack innate abilities (Sekaquaptewa, 2011), we expected that women would feel like they are putting forth more effort than their peers in science and mathematics classes even though their objective performance is equivalent to that of men's. Additionally, because these differences in perceptions of effort might be the product of internalized messages about the importance of effort and public performance of ability in a field, we included a measure of achievement motivation to control for the influences of these individual beliefs.

Environmental Factors Affecting STEM Classroom Experiences

In addition to internal motivational factors, the STEM classroom environment plays an important role in shaping students' STEM outcomes (Riegle-Crumb & Morton, 2017). Characteristics of the individuals in the class, including the gender of the instructor and the gender composition of classroom peers, can affect identification and engagement with the classroom material (Eddy et al., 2014; Haley, Johnson, & Kuennen, 2007). Another potential explanation for the STEM gender gap at the college level is disparities in class participation. Greater class participation is related to how much students like the class in general (Crombie, Pyke, Silverthorn, Jones, & Piccinin, 2003) and how anxious they feel about their performance in the class (Fassinger, 2000). Although much work explores gender differences in participation in non-STEM college courses (Howard Zoeller & Pratt, 2006; Tatum, Schwartz, Schimmoeller, & Perry, 2013), less is known about men and women's patterns of class participation in STEM classrooms. Previous research has found that when instructors of STEM courses were female, women participated more in the classroom (Stout, Dasgupta, Hunsinger & McManus, 2011; Young, Rudman, Buettner & McLean, 2013). In addition to the gender of the instructor, the design of the class itself seems to have an impact on participation. Undergraduate women in college science courses report lower participation in whole class discussions (Micari & Drane, 2011) and less comfort in leading small group discussions (Crombie, Pyke, Silverthorn, Jones, & Piccinin, 2003) compared to men. Gendered patterns of classroom engagement favoring males may even occur in science courses where women are better represented, such as biology (Eddy, Brownell, Thummaphan, Lan, & Wenderoth, 2015; Eddy, Brownell & Wenderoth, 2014). In order to understand whether this pattern is generalizable to other STEM classroom experiences, this study examined classroom participation in a range of undergraduate science, mathematics, and social science classes.

RESEARCH QUESTIONS AND HYPOTHESES

The primary purpose of our study was to determine whether there are any gender differences in perceptions of work ethic, ability and participation among college students in a range of college courses. Specifically, our research questions were broken down into two main phases of our analyses: first, are there significant differences in women's and men's perceptions of their ability, work ethic, and class participation in STEM fields? And do these perceptions differ depending on the type of STEM field about which they are responding (either a college science, mathematics, or social science class)? Based on previous research indicating that women underrate their performance in STEM relative to their peers (e.g., Grunspan et al., 2016), we predicted that men would perceive their STEM ability and participation to be higher relative to their classroom peers than would women. However, we predicted that women would perceive their work ethic to be higher relative to their peers than men would (Smith et al., 2012). We had an exploratory hypothesis that men's perceptions of their ability and participation would be even higher relative to women's perceptions in classes that are in more traditionally male-dominated fields (science and mathematics) than in classes in more female-dominated subjects (social science).

Second, in addition to looking for possible gender differences in our main outcome variables, we wanted to determine whether the factors that influence perceptions of ability, work ethic, and participation in science, mathematics, and social science vary across men and women. Specifically, we examined the effects of factors at three different levels of students' experiences: a) individual factors such as the student's gender and their grade in the course, b) internal motivational factors (i.e., performance orientation and mastery orientation), and c) classroom level factors (i.e., the gender of the instructor and the gender composition of the class). Based on Elliot and Church's (1997) theoretical framework, we predicted that having higher levels of mastery orientation would positively predict perceptions of work ethic across subjects, while having higher levels of performance-approach orientation would positively predict students' perceptions of their classroom participation and ability relative to their peers. Importantly, in this final step of the analyses, we included the interaction between the gender of the instructor and the gender composition of the class as a predictor of individual outcomes because the interplay between student and instructor gender has been shown to affect STEM outcomes as well (Haley et al., 2007).

METHOD

Participants

Participants included 197 (133 women, 59 men, 5 gender-variant/non-binary) undergraduate students at a mid-sized public university in the southwestern United States. Self-reported ethnic background included European American (58.2%), Latinx (23.2%), African American (12.4%), and Asian American (5.2%). Participants ranged in age from 18 to 46 years old (M = 21.59 years, SD = 5.14). The male students in our sample were significantly older than the female students, on average (t (82.21) = 2.23, p = .04, equal variances not assumed).
We want to define and clarify our operational definition of "STEM fields" for this project. There is little consensus on the inclusion and exclusion of nursing and other science related fields in STEM. For example, the U.S. Bureau of Labor Statistics (2014) classifies nursing as a STEM field, while other researchers exclude health-related majors from STEM research (Hill, Corbett, & St. Rose, 2010). Given that the nursing and health sciences majors at the target institution in our study are required to take many of the same courses and sit in the same classes as other STEM majors (e.g., biology), we included nursing majors as STEM for the purposes of our analyses.

A little more than half (55.4%) of the students in our sample were STEM majors, which included biology, chemistry, engineering, mathematics, computer science, and nursing/health sciences.

Out of our total sample, 157 (79.7%) students had already taken at least one math and one science class in college. The 13 students who reported that they had not yet taken either a college science or math class at the time of the survey were not included in the analyses about students' perceptions of their college math and science classes.

Overview of the Procedure

College students were recruited to complete a 30-minute online survey about their college classroom experiences. Participants were recruited from a range of classes from various departments. The survey included questions about the students' personal and demographic characteristics, their academic achievement, and their general academic motivation.

Additionally, we asked students to rate their experiences in their most recent (a) college science class, (b) college mathematics class and (c) college social science class. Importantly, at the beginning of each of these series of questions, we gave students descriptions of the kinds of classes we wanted them to answer about. For the section about their most recent science class, the description read: "The following questions will address the last science class that you took. 'Science' classes can include subjects such as biology, chemistry, physics, and computer science. We will ask about social sciences (like psychology) and math classes later." For the section about their last math class, the description included the statement, "The following questions will address the last math class that you took. For this question, you can include any statistics classes that you took in any department." Finally, the description for the social science section read, "The following questions will address the last social science class that you took. 'Social science' includes classes in psychology, sociology, and anthropology."

In each of these subject-specific sections, students reported information about their performance in the class, their study habits in the class, their performance relative to their peers in the class, and the gender composition of the class.

Measures

Demographic characteristics

Participants were asked to report their age, gender, race and ethnicity, academic major, current cumulative GPA and type of institution they attend.

Course experiences, by subject

In each of the subject-specific sections (experiences in the most recent college science, math, and social science course), students reported several different types of information about their performance and their peers in the class: (a) whether they had taken a course yet in college that matched the description, (b) the name of the most recent class that they had taken in that category, (c) how long ago they took the course (options were: currently enrolled, 1-2 years ago, or more than 2 years ago), the gender of the course instructor, and their best estimate of the percentage of the students in the course who were women.

Participants also completed several questions comparing themselves to other students in the course. We asked students to place themselves relative to other students in their most recent course in each subject area in terms of their (a) ability in the subject, (b) work ethic in the course, and (c) participation in class. Students rated themselves using a percentile rank from 0 to 100, with anchors of "0 = very worst in the class", "50 = middle of the class", and "100 = very top/best in the class" presented with the scale.

Self-reported grades

Participants were asked to report their grade in the different academic subjects (ranging from "A" to "F"). Scores ranged from 1 to 5, where a score of 5 means they received an A in the course. A meta-analysis conducted by Kuncel, Crede, and Thomas (2005) indicated average correlations between self-reported grades and school records were .84 for math and .82 for science. The authors noted that self-reported grades and actual grades generally predict outcomes similarly. Because the survey was distributed near the end of an academic semester, we asked students who were reporting about a class in which they were currently enrolled to choose the grade that reflected their performance in the class up to that point in the semester.

Academic motivation
We measured academic motivation using Elliot and Church's (1997) Achievement Motivation Inventory. The scale contains 18 items that map onto three different styles of academic achievement motivation: (1) performance-goal approach ("I am striving to demonstrate my ability relative to others in my classes."), (2) mastery-goal approach ("I want to learn as much as possible from my classes.") and (3) performance-avoidance goal ("I worry about the possibility of getting a bad grade in my classes."). We modified the wording of the questions slightly so that questions that sounded like they asked about a specific class (e.g., "My fear of performing poorly in this class is often what motivates me.") were reworded to ask about classes in general (e.g., "My fear of performing poorly in my classes is often what motivates me."). Participants rated their agreement with each statement on a scale from 1(Strongly disagree) to 5 (Strongly agree). Cronbach's alpha reliability statistics for each of the three subscales were as follows: performance-goal approach (α = .92), mastery-goal approach (α = .89), and performance-avoidance (α = .73).

RESULTS

Descriptive Analyses of the Courses Taken

We will begin our analyses by describing the courses that students reported as their most recent college science, mathematics, and social science class. We thought it would be important to begin any comparison of students' experiences in different types of classes by first describing the courses that were nominated to fit into each specific area, and whether there are gender differences or major differences in the types of mathematics, science, and social science courses that students nominated.

Most recent college science class
The majority (83.2%) of our sample reported having taken at least one science class while in college. There was no significant relationship between having a declared major in a STEM discipline and having taken a science class, χ^2 (1, 186) = .007, p = .93, possibly because students at the sample university are required to take a minimum of two science courses as a part of their general education requirements, regardless of major. Of the science classes reported, 31.6% were a type of biology class (e.g., introduction to biology, genetics, microbiology), 24.7% were a type of chemistry class (e.g., introduction to chemistry, organic chemistry, physical chemistry), 17.0% were a health or physiology course (e.g., nutrition, anatomy and physiology), 4.1% were a type of earth science course (e.g., geology, conservation science), 4.1% were a type of physics course (e.g., introductory physics, mechanics), and the remaining 2.0% fell into other categories (e.g., engineering, life sciences). Most students reported taking their most recent science class close to the time of the survey (46.5% were currently enrolled in a science course, 45.3% had taken a science course in the last 2 years, and only 8.2% reported that their last science class was more than two years prior to the survey).

Of the courses listed by students, 62.6% are considered "lower-level" (freshman and sophomore level) classes at the university, and 14.7% were considered "upper-level" (junior and senior level classes). For the remaining courses, we were unable to classify the level of the course based on the description listed by the participant. There were no gender differences or major differences in the frequency of reporting on upper- or lower-level science courses in the survey.

Most recent college mathematics class

The majority (75.3%) of our sample reported having taken at least one mathematics or statistics class in college. There was a significant relationship between having a declared major in a STEM discipline and having taken at least one mathematics course in college, χ^2 (1, 186) = 16.38, p <.001, Cramer's V = .30. A significantly higher percentage of students in STEM majors had taken at least one math class (88.2%) compared to our students majoring in non-STEM disciplines (63.1%). This difference is likely attributed to the higher level of mathematics courses required for students majoring in STEM fields.

There were no gender differences in the frequency of male and female students taking mathematics courses, χ^2 (1, 186) = .10, p = .76. Of the mathematics classes reported, 58.9% were statistics courses, 8.9% were calculus courses, 27.4% were below calculus-level (i.e., college algebra, math for liberal arts majors, pre-calculus), and the remaining 4.8% were other upper-level math classes (e.g., abstract algebra I & II, finite math). Most students reported taking their last mathematics or statistics class close to the time of the survey (32.4% were currently enrolled in a math or statistics course, 57.0% had taken a math or science class in the past two years but were not currently enrolled, and 10.6% reported that their last mathematics or statistics class was more than two years prior to the survey).

Most of the mathematics courses listed were lower-level courses (95.9%), except for three students who were also mathematics majors and had taken upper-level math courses.

Most recent college social science class

A total of 81.1% of our sample had taken at least one social science class in college. There was no relationship between a student's gender and whether they had taken a social science class, χ^2 (1, 185) = .06, p =.81. There was, however, a significant relationship between college major and having taken a social science class; significantly fewer STEM majors (70.2%) compared to non-STEM majors (90.1%) had taken a social science class thus far in college.

Of the social science classes nominated by participants in the study, 55.7% were lower-level psychology courses (e.g., introduction to psychology, which fulfills a general education requirement at the sample university), 31.3% were upper-level psychology classes (e.g., physiological psychology, social psychology), 6.1% were political science and economic courses, and 6.9% were sociology/anthropology courses. Among the students who had taken at least one social science class, 67.8% were enrolled in such a class at the time of the survey, 22.1% were not currently enrolled but had taken such a class in the last two years, and the remaining 10.1% had taken a social science class two or more years prior to our survey.

Gender Differences and Similarities in Primary Outcome Variables
Next, we examined whether women's and men's ratings of their ability, work ethic, and classroom participation differed overall, and whether these ratings differed depending on the type of class for which students were recounting their experiences. To review, we hypothesized that men's perceptions of their ability in STEM courses would be higher than those of their female peers. We thought that women, more than men, would perceive that they were working harder in their STEM classes than their peers. Finally, we predicted that men, more than women, would rank themselves higher than their STEM classroom peers in terms of participation.

First, we examined gender differences in perceptions of ability relative to classroom peers in mathematics, science, and social science classes using a multivariate analysis of variance (MANOVA). Results showed that there was not a significant effect of gender on ability perceptions across the three subject areas, F (3, 106) = 2.15, p = .10, Wilks' lambda = .94. That is, women and men rated their ability similarly in STEM classes.

Next, we examined gender differences in perceptions of work ethic relative to classroom peers using a MANOVA. Results showed a significant overall effect of gender on work ethic ratings, F (3, 106) = 5.78, $p < .001$, Wilks' lambda = .86, partial $\eta^2 = .14$. Follow-up univariate tests showed that women rated their work ethic significantly higher than men did relative to their peers in science classes (F (1, 108) = 13.03, $p < .001$, partial $\eta^2 =.11$), mathematics classes (F (1, 108) = 9.16, $p < .01$, partial $\eta^2 =.08$), and social science classes (F (1, 108) = 11.9, $p < .001$, partial $\eta^2 = .10$). To further investigate these gender differences in perceptions of how hard a student is working relative to their peers, we conducted a MANOVA to determine whether female students reported studying more hours per week for their classes relative to the male students in our sample. There were no differences in the number of hours that men and women reported studying overall, nor were there gender differences in hours studied across individual subject areas, F (3, 108) = .74, p = .53. Thus, although women reported working harder in their STEM classes than men did, their self-reported number of hours studying did not differ significantly from those reported by their male peers.

Finally, we examined gender differences in perceptions of classroom participation relative to peers in the three subject areas. Results of a MANOVA showed a non-significant gender difference in perceptions of participation overall, F (3, 106) = 2.56, p = .06, Wilks' lambda = .93. Because the omnibus test result was marginally significant, and because we had an a-priori hypothesis that men would perceive themselves to have higher levels of classroom participation than women across STEM subjects, we chose to investigate the univariate tests for each subject using a Bonferroni-corrected alpha level of .016. These tests revealed a significant gender difference for perceived classroom participation in both mathematics (F (1, 108) = 5.74, p = .016) and science classes (F (1, 108) = 6.23, p = .013), but similar ratings in social science classes (*F* (1, 108) = 1.51, *p* = .22). Contrary to our hypotheses, women's rankings of their participation in both mathematics (*M* = 76.9, *SD* = 23.67) and science (*M* = 74.6, SD = 23.8) classes were significantly higher than men's rankings of their classroom participation in both subjects (*M* = 65.9, *SD* = 32.5 and *M* = 64.9, *SD* = 31.35, respectively).

Predictors of Self-Reported Class Experiences, by Discipline

In this section, we will examine the predictors of students' classroom experiences within each discipline using a series of regression analyses predicting three key outcomes: students' perceptions of their ability relative to their classmates, students' perceptions of their work ethic relative to their classmates, and students' perceptions of their class participation relative to their classmates.

Predictors of ability perceptions across disciplines

For perceived ability in each subject area, we conducted the following hierarchical linear regression models. For each model, the dependent variable was perceived ability relative to their classmates. In Step 1, we entered the participants' gender and grade in the course as predictors. In Step 2, we entered the variables related to students' academic motivations: mastery goal orientation, performance-approach score, and performance-avoidance score. In Step 3, we entered the gender characteristics of the class, including the gender of the instructor, the gender composition of the students in the class, and the teacher gender X peer gender composition interaction term.

Perceptions of science ability

For the full results of the hierarchical regression model, see Table 1. As expected, the first step of the model significantly predicted perceptions of science ability, *F* (2, 142) = 75.98, $p < .001$. Within this step, only the grade received in the most recent science class significantly predicted perceptions of ability, $\beta = .72$, $p < .001$. The addition of the academic motivation variables did not significantly add to the predictive ability of the model although the overall model remained significant, $\Delta R^2 = .01$, $p = .31$; *F* (5, 139) = 31.24, $p < .001$. Similarly, the addition of the gender composition variables in the third step of the model did not add any predictive ability to the overall model $\Delta R^2 = .009$, $p = .45$; *F* (8, 136) = 19.80, $p < .001$.

Table 1. Hierarchical regression predicting perceptions of science ability.

Model Information	**Step 1:** R^2 adjusted = .52	**Step 2:** R^2 adjusted = .51 ΔR^2=.01, p = .31	**Step 3:** R^2 adjusted = .51 ΔR^2=.009, p = .46
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.06 (.31)	.05 (.38)	.04 (.45)
Science Course Grade	.72***	.70***	.70***
Mastery Orientation		.07 (.27)	.07 (.27)
Performance Goal		.06 (.34)	.06 (.34)
Performance Avoidance		-.07 (.26)	-.06 (.27)
Teacher Gender			.25 (.24)
Class Gender Composition			.17 (.16)
Teacher X Class Gender Interaction			-.37 (.16)

Note. *** p<.001

Table 2. Hierarchical regression predicting perceptions of mathematics ability.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .53	R^2 adjusted =.57	R^2 adjusted = .58
		ΔR^2=.03, p = .06	ΔR^2=.01, p = .84
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.05 (.46)	.03 (.60)	.02 (.75)
Math Course Grade	.71***	.68***	.70 ***
Mastery Orientation		.14*	.14*
Performance Goal		.03 (.71)	.03 (.90)
Performance Avoidance		-.14 (.03)	-.18 (.10)
Teacher Gender			.05 (.31)
Class Gender Composition			-.07 (.87)
Teacher X Class Gender Interaction			-.01 (.87)

Note. * p<.05, *** p<.001

Perceptions of mathematics ability
For the full results of the hierarchical regression model, see Table 2. As expected, the first step of the model significantly predicted perceptions of mathematics ability, F (2, 126) = 62.18, $p < .001$. Within this step, only the grade received in the most recent mathematics class significantly predicted perceptions of ability, β = .71, $p < .001$. The addition of the academic motivation variables added marginally to the predictive ability of the model, $\Delta R^2 = .03$, $p = .06$; F (5, 123) = 27.29, $p < .001$. In this step, both the grade received in the course (β = .68, $p < .001$) and higher levels of mastery orientation (β = .14, $p < .05$) predicted higher levels of perceived mathematics ability. The addition of the course gender composition variables in the third step of the model did not add to its predictive ability though the overall model remained significant, $\Delta R^2 = .01$, $p = .92$; F (8,99) = 7.32, $p < .001$.

Perceptions of social science ability
For the full results of the hierarchical regression model, see Table 3. Unlike the models predicting perceptions of mathematics and science ability, both predictors in the first step of the model significantly predicted perceptions of social science ability, F (2, 119) = 31.40, $p < .001$; both the grade received in the class (β = .55, $p < .001$) and being female (β = .26, $p < .01$) predicted higher perceived social science ability. Neither the addition of the academic motivation variables in Step 2 ($\Delta R^2 = .03$, $p = .12$; F (5, 116) = 14.18, $p < .001$), nor the addition of the gender composition variables in Step 3 ($\Delta R^2 = .01$, $p = .46$; F (7, 114) = 10.31, $p < .001$) added to our ability to predict perceptions of social science ability.

Predictors of work ethic perceptions across disciplines
For perceived work ethic relative to their classmates in each subject area, we conducted the following hierarchical linear regression models. For each model, the dependent variable was perceived work ethic relative to their classmates. In Step 1, we entered participants' gender, grade in the course, and the self-reported number of hours that they studied each week for the course as predictors. In Step 2, we entered the variables related to students' academic motivations: mastery goal orientation, performance-approach score, and performance avoidance score. In Step 3, we entered the gender characteristics of the class, including the gender of the instructor, the gender composition of the students in the class, and the teacher gender X peer gender composition interaction term.

Perceptions of science work ethic
For the full results of the hierarchical regression model, see Table 4. The first step of the model significantly predicted perceptions of science work ethic, F (3, 141) = 21.76, $p < .001$. Within this step, all three variables significantly predicted perceptions of work ethic; female students rated their work ethic significantly higher than male students did relative to their classroom peers, β = .23, $p < .001$. Additionally, participants who had received higher grades in the course (β = .30, $p < .001$) and who reported studying more hours per week (β = .41, $p < .001$) also perceived themselves to be working harder relative to their peers. The addition of the academic motivation scales in Step 2 (F (6, 138) = 11.36, $p < .001$) and the gender composition of the course in Step 3 (F (9, 135) = 7.79, $p < .001$) of the

model did not significantly add to our ability to predict perceptions of science work ethic.

Perceptions of mathematics work ethic

For the full results of the hierarchical regression model, see Table 5. The first step of the model significantly predicted perceptions of mathematics work ethic, F (3, 126) = 30.10, $p < .001$. Within this step, all three variables significantly predicted perceptions of work ethic; female students rated their work ethic significantly higher than male students did relative to their math classroom peers, $\beta = .31$, $p < .001$. Additionally, participants who had received higher grades in their most recent math course ($\beta = .33$, $p < .001$) and who reported studying more hours for the course per week ($\beta = .49$, $p < .001$) also perceived themselves to be working harder relative to their peers. The addition of the academic motivation scales in Step 2 (F (6, 123) = 15.16, $p < .001$) and the gender composition of the course in Step 3 (F (9, 120) = 10.10 $p < .001$) of the model did not significantly add to our ability to predict perceptions of mathematics work ethic.

Perceptions of social science work ethic

For the full results of the hierarchical regression model, see Table 6. The first step of the model significantly predicted perceptions of social science work ethic, F (3, 118) = 13.60, $p < .001$. Within this step, all three variables significantly predicted perceptions of work ethic; female students rated their work ethic significantly higher than male students did relative to their classroom peers in a social science course, $\beta = .32$, $p < .001$. Additionally, participants who had received higher grades in their most recent social science course ($\beta = .18$, $p < .05$) and who reported studying more hours for the course per week ($\beta = .35$, $p < .001$) also perceived themselves to be working harder relative to their peers. The addition of the academic motivation scales in Step 2 (F (6, 115) = 9.82, $p < .001$) significantly increased the predictive ability of the model. Specifically, in social science classes, students with higher mastery orientation scores ($\beta = .22$, $p < .01$) and lower levels of performance avoidance ($\beta = -.21$, $p < .01$) perceived themselves to be working harder relative to their classroom peers. The addition of the gender composition of the classroom variables in Step 3 (F (9, 112) = 7.00 $p < .001$) of the model did not significantly add to our ability to predict perceptions of social science work ethic.

Table 3. Hierarchical regression predicting perceptions of social science ability.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .32	R^2 adjusted =.34	R^2 adjusted = .32
		ΔR^2=.03, p = .18	ΔR^2=.01, p = .92
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.23**	.20**	.18*
Social Science Course Grade	.55***	.53***	.52***
Mastery Orientation		.17*	.12 (.17)
Performance Goal		.04 (.62)	.08 (.34)
Performance Avoidance		-.10 (.20)	-.13 (.13)
Teacher Gender			-.002 (.98)
Class Gender Composition			.05 (.57)
Teacher X Class Gender Interaction			-.03(.76)

Note. * p<.05, **p<.01, *** p<.001

Table 4. Hierarchical regression predicting perceptions of work ethic in college science classes.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .32	R^2 adjusted = .33	R^2 adjusted = .34
		ΔR^2=.01, p = .40	ΔR^2=.01, p = .53
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.23***	.22***	.20**
Course Grade	.30***	.27***	.27***
Hours studied	.41***	.41***	.40***
Mastery Orientation		.08 (.32)	.08 (.31)
Performance Goal		.04 (.63)	.03 (.69)
Performance Avoidance		-.11 (.15)	-.11 (.15)
Teacher Gender			.16 (.53)
Class Gender Composition			.16 (.42)
Teacher X Class Gender Interaction			-.12(.70)

Note. **p<.01, *** p<.001

Table 5. Hierarchical regression predicting perceptions of work ethic in college mathematics classes.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .40	R^2 adjusted =.40	R^2 adjusted = .39
		ΔR^2=.008, p = .65	ΔR^2=.005, p = .77
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.31***	.30***	.29***
Course Grade	.33***	.33***	.32***
Hours Studied	.49***	.48***	.49***
Mastery Orientation		.01 (.87)	.003 (.97)
Performance Goal		.08 (.29)	.09 (.28)
Performance Avoidance		.001 (.98)	-.001 (.95)
Teacher Gender			.11 (.64)
Class Gender Composition			.15 (.35)
Teacher X Class Gender Interaction			-.19 (.54)

Note. *** p<.001

Table 6. Hierarchical regression predicting perceptions of work ethic in college social science classes.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .24	R^2 adjusted =.30	R^2 adjusted = .31
		ΔR^2=.08, p <.01	ΔR^2=.02, p = .30
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.32***	.28***	.27***
Course Grade	.18*	.13 (.10)	.14 (.08)
Hours Studied	.35***	.33***	.32***
Mastery Orientation		.22**	.19*
Performance Goal		.11 (.20)	.10 (.23)
Performance Avoidance		-.21**	-.19*
Teacher Gender			.03 (.92)
Class Gender Composition			.15 (.14)
Teacher X Class Gender Interaction			-.10(.76)

Note. * p<.05, ** p < .01, *** p<.001

Predictors of perceptions of classroom participation across disciplines
For perceived classroom participation relative to their classmates in each subject area, we conducted the following hierarchical linear regression models. For each model, the dependent variable was perceived classroom participation relative to their classmates. In Step 1, we entered participants' gender and grade in the course. In Step 2, we entered the variables related to students' academic motivations: mastery goal orientation, performance-approach score, and performance-avoidance score. In Step 3, we entered the gender characteristics of the class, including the gender of the instructor, the gender composition of the students in the class, and the teacher gender X peer gender composition interaction term.

Perceptions of science class participation
For the full results of the hierarchical regression model, see Table 7. The first step of the model significantly predicted perceptions of science class participation, F (2, 141) = 11.25, $p < .001$. Within this step, both the gender of the student (female students rated themselves higher in terms of participation than did male students, $\beta = .19$, $p < .05$) and the grade received in the science course ($\beta = .40$, $p < .001$) predicted students' higher ratings of their own class participation. The addition of the academic motivation scales in Step 2 (F (5, 138) = 5.87, $p < .001$) and the gender composition of the course in Step 3 (F (8, 135) = 3.97, $p < .001$) of the model did not significantly add to our ability to predict perceptions of science classroom participation.

Perceptions of mathematics class participation
For the full results of the hierarchical regression model, see Table 8. The first step of the model significantly predicted perceptions of mathematics class participation, F (2, 126) = 9.23, $p < .001$. Within this step, both the gender of the student (female students rated themselves higher in terms of participation than did male students, $\beta = .22$, $p < .01$) and the grade received in the mathematics course ($\beta = .30$, $p < .001$) predicted students' higher ratings of their own participation. The addition of the academic motivation scales in Step 2 (F (5, 123) = 3.9, $p < .01$) and the gender composition of the course in Step 3 (F (8, 120) = 3.10, $p < .01$) of the model did not significantly add to our ability to predict perceptions of mathematics classroom participation.

Perceptions of social science class participation
To predict students' perceptions of their participation in social science courses, we conducted an analogous hierarchical regression model to the models we ran for science and mathematics classroom participation. However, Step 1 of the model (which included participant gender and their social science course grade) did not explain a significant amount of the variance in students' perceptions of how much they participated in their most recent social science course, F(2, 118) = 2.25, $p = .11$, R^2 adjusted = .04. The addition of academic motivation variables in Step 2 (F (5, 115) = 1.39, $p = .23$) and the gender composition of the class in Step 3 (F (8, 112) = 1.39, $p = .21$) did not significantly increase the predictive ability of the model.

Table 7. Hierarchical regression predicting perceptions of class participation in college science classes.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .14	R^2 adjusted = .18	R^2 adjusted = .19
		ΔR^2=.04, p = .10	ΔR^2=.02, p = .46
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.19*	.17*	.17*
Course Grade	.40***	.33***	.33***
Mastery Orientation		-.07 (.39)	-.08 (.37)
Performance Goal		.21*	.21*
Performance Avoidance		.02 (.86)	.02 (.85)
Teacher Gender			.38 (.20)
Class Gender Composition			.08 (.62)
Teacher X Class Gender Interaction			-.35(.31)

Note. * p<.05, *** p<.001

Table 8. Hierarchical regression predicting perceptions of class participation in college mathematics classes.

Model Information	**Step 1:**	**Step 2:**	**Step 3:**
	R^2 adjusted = .13	R^2 adjusted =.14	R^2 adjusted = .17
		ΔR^2=.01, p = .73	ΔR^2=.03, p = .20
Predictor	**β (*p*)**	**β (*p*)**	**β (*p*)**
Participant Gender	.22**	.26**	.20*
Course Grade	.30***	.31***	.29***
Mastery Orientation		-.08(.43)	-.10(.27)
Performance Goal		.09 (.34)	.10(.30)
Performance Avoidance		.03(.75)	.03(.75)
Teacher Gender			-.08(.78)
Class Gender Composition			.19 (.31)
Teacher X Class Gender Interaction			.00(.99)

Note. * p<.05, ** p < .01, *** p<.001

DISCUSSION

As the percentage of women taking college classes across disciplines increases (National Center for Education Statistics, 2018), we as researchers must examine the experiences of an increasingly diverse student body in the sciences and social sciences. In our study, we wanted to examine the experiences of male and female students in specific courses that they have taken in college science, mathematics, and social science. We chose to ask about experiences in these three types of classes because, nationally, these broad fields cover the spectrum of women's representation in STEM; in 2017 at the bachelor's degree level, 77% of psychology degree recipients were women, compared to 55% of science degree recipients and 24% of mathematics and computer science degree recipients (NSF, 2018). The purpose of our study was to examine the experiences of students in these types of classes, specifically how they perceived that they stood in relation to their classroom peers in terms of ability in the subject matter, work ethic in the class, and participation during class. We predicted that women's perceptions of how they stood out relative to their classmates would correlate with the gender composition of the discipline generally; that is, we thought that women would see themselves as more able and participatory compared to their peers in social science classes than in mathematics and science classes. Additionally, we predicted that motivation variables at the student level, such as mastery and performance orientation, and gender composition at the classroom level (teacher gender and percentage of female peers) would relate to students' perception of their performance in the course as well.

First, we examined women's and men's experiences in their STEM classes by asking them to rate their ability in the subject, work ethic, and participation in class relative to their classroom peers. Women and men rated their ability similarly high across science, mathematics, and social science classes. This finding was somewhat surprising given the body of research that has shown that women tend to have a lower perception of their ability than their male peers do in STEM classes (MacPhee, Farro, & Canetto, 2013; Nix, Perez-Felkner, & Thomas, 2015). The lack of a gender difference in ability perceptions may be evidence of a new trend as women become increasingly represented in undergraduate STEM and social science fields (NSF, 2018). However, future studies should attempt to replicate these findings to determine their generalizability to other types of schools and levels of STEM education.

Perceptions of classroom participation were largely similar for women and men in all three types of STEM classes that we assessed. However, we did find small gender differences favoring women in their perceptions of classroom participation in mathematics and science classes. This finding was contrary to what we hypothesized, especially given the body of research that has shown than men participate and answer questions in large group discussion more than women do in college classes (Crombie et al., 2003; Eddy et al., 2014, 2015). There are several possible explanations for this unexpected finding regarding class participation. First, the wide range of classes that we chose to include in each domain of science, mathematics, and social science may have washed out any potential gender disparities in individual classes. However, it is possible that, because our method of measuring participation came entirely from student self-reports, students are not reliable coders of their own participation frequency. Finally, we were surprised that the gender of the class instructor did not influence students' participation given the previous studies that found female students were more likely to participate in STEM classes taught by a female instructor (Stout et al., 2011; Young et al., 2013). Perhaps this lack of an effect of the gender of the instructor is somewhat due to a ceiling effect of women's participation in our sample; because the women in our sample perceived themselves to be as participatory as men, we lost some statistical power to differentiate factors that could increase participation even further.

The largest difference we found between women and men in their perceptions of their performance was in the domain of work ethic; compared to the men in our study, women reported working significantly harder than their classroom peers in all three disciplines. This large difference in work ethic perceptions did not match the pattern we saw in students' self-reported time that they spent studying. Women and men reported studying for similar numbers of hours within the same discipline (there was a difference across disciplines, such that students, in general, reported studying more hours per week for math classes than science or social science classes). These findings are consistent with work by Smith et al. (2012) that showed women in STEM think that they must be working harder than their male peers, even when they see themselves to be similarly able and high achieving. However, it is important to consider these results in the context of the study by Grunspan and colleagues (2016) who showed that male students in STEM classes tend to overestimate their performance relative to their peers. It is possible that our sample of male students is over-reporting the number of hours that they spend studying for class, which could lead to an inflated view of their work ethic in the class.

Next, we examined whether gender and course grades predicted our variables of interest (students' ability beliefs, work ethic, and class participation). We found that women did not underrate their ability in STEM (both math and science) college classes relative to their male peers. However, our regression models showed that women rate their ability in social science classes as higher than their peers when course grades are accounted for simultaneously. This could be explained by the overrepresentation of women in the social sciences (NSF, 2018), and thus women in these classes may feel more of a sense of belonging that contributes to a heightened perception of ability in that subject (Master, Cheryan, & Meltzoff, 2016). Across all types of classes, men's and women's final letter grade in the class was strongly correlated with how they ranked themselves in terms of ability. However, women did report working significantly harder than their classroom peers in all three subjects, and participating more than other peers in STEM classes, while receiving the same grades in their classes.

Next, we examined how motivational factors (e.g., mastery goal orientation and approach to performance) predicted our outcome variables. Motivational factors did not significantly predict ratings of science or social science abilities; however, mastery goal orientation had a moderate impact on how students rated their math ability. We found that motivational factors did not predict perceptions of work ethic in science and math courses. However, in our sample, higher levels of mastery goal orientation and lower levels of performance avoidance did influence how students rated their work ethic in social science courses; students with higher mastery goal orientation rated their work ethic significantly higher, and those with performance avoidance goals rated their work ethic lower. The link between academic goal orientation and work ethic is somewhat consistent with the theoretical model proposed by Elliot and Church. Although the link was not consistent across all subjects tested in our study, it was closest for social science, which was the subject area originally tested in Elliot and Church's 1997 study. Additionally, motivational factors did not predict class participation across all course subjects.

We found that the gender characteristics of the class, including the gender of the instructor and the gender composition of the students in the class, did not predict ratings of ability, work ethic or class participation. One possible reason for this lack of an effect is the breadth of types of classes that were reported on within our study. So much of students' feelings of efficacy in a class is due to the difficulty and subject matter of the specific class (Harackiewicz, Barrom, Tauer, & Elliot, 2002; Heilbronner, 2011) that it is possible any effects due to gender of the individual instructor or peers were overshadowed.

LIMITATIONS AND FUTURE DIRECTIONS

One limitation of the current study is our focus on students' most recent science, mathematics, and social science courses as a measurement of college classroom experiences more broadly. Focusing on and describing only a single, recent STEM class does not give us the full picture of a student's experiences in a discipline, or in college classes in general. However, we do believe there are benefits to asking students about a specific, recent class; specifically, students may be more accurate in describing their performance and experiences in a single class than they would be if asked to make general statements about their experiences in an entire field. Thus, our results should not be taken to speak towards women's experiences towards science in general, but more specifically how factors at play within a given class in a subject area can impact experiences in that class.

Additionally, we did not ask *how many* classes in a subject area that participants had taken, information which could have proven useful as a control variable in our analyses predicting students' perceptions of ability and work ethic. That is, as students gain experience in college mathematics classes, for example, they may construct more realistic expectations for how much they and their peers should be working and participating to be successful in the class. In future studies, we plan to investigate additional intra-subject predictors of classroom experiences such as these. Furthermore, we would like to expand this research using a more intersectional lens to examine the multiple identities that students bring to college classrooms in addition to their gender, such as race, ethnicity, age, and socioeconomic status, that certainly impact their identification with and engagement in the subject matter (Rascoe & Atwater, 2005; Riegle-Crumb & King, 2010; Tsui, 2007).

Additionally, our data about classroom experiences are drawn solely from students' perceptions of their behaviors relative to their peers. Using self-reported perceptions is useful for learning about the internal experiences of students in STEM classes (Cole, Maxwell, & Martin, 1997; Marsh, 1986; Muenks et al., 2016) but may benefit from comparison with an observation of these behaviors in a classroom as well (Ballen, Lee, Rakner, & Cotner, 2018; Eddy et al., 2014). For example, our measure of classroom participation came from students' perceptions of how much they participated in their classes relative to their peers, rather than from direct observation of participation across classes. We found small gender differences favoring women in students' responses to this question across math and science classes, which diverges from a body of literature showing that female students speak proportionally less than their male peers in science classes (Eddy et al., 2014, 2015; Grunspan et al., 2016). Indeed, it is possible that our sample of college women simply participates more than the women studied in other samples, but these participation results especially bear further investigation. Regardless, we believe that it is important to document that women in our sample *perceived* that they participate in class similarly to or more than the men in our sample. In sum, we believe that we were able to gather valuable cross-sectional data from classes across a variety of majors and levels within each major, which we believe provide a worthwhile examination of STEM classroom experiences.

Finally, we believe it is important for future researchers to continue to examine the differences among experiences in sub-disciplines of STEM; our study adds to the growing body of research that shows that gendered experiences in STEM differ as a function of the composition of the discipline (Ceci, Ginther, Kahn, & Williams, 2014; Ceci & Williams, 2010). Thus, based on the results of our study, we believe it is important for researchers to consider a wide range of both individual and environmental factors when examining the gendered experiences of college students in STEM classes.

The breadth of types of classes that students consider to be "STEM", alone, can inform the discussion of how college students conceptualize and identify with different academic subjects and disciplines. Our findings that women and men perceive their ability similarly across a range of STEM classes is a promising trend for women's persistence in STEM that bears further investigation. Our results emphasize that women and men may judge their performance, ability, and effort relative to their peers differently even when they receive the same grade in a course. It is important for educators and advisors in higher education to consider the range of factors, like those examined in our study, that influence students' perceptions of how "good" they are in different subject areas in college.

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