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# Exploring teachers' and students' gender role bias and students' confidence in STEM fields

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**Abstract** There is a shortfall of girls and women pursuing STEM disciplines, a deficit that may be partially attributed to subtle forms of bias that are tied to traditional gender role stereotypes. The current study examined these subtle biases in high school teachers and students in two ways: by asking teachers and students to attribute masculine and feminine traits to the typical scientist or humanities professional, and by inquiring about the academic performance assumed of boys and girls. In addition, students were surveyed about their own self-efficacy in math and science courses and gender-balanced teaching initiatives present in the classroom. Results showed that teachers and students exhibited subtle bias by attributing more masculine characteristics to a scientist and feminine characteristics to the humanities. Teachers and students also reported their belief that boys tend to perform better than girls in STEM disciplines. Finally, our results echoed previous literature examining self-efficacy discrepancies for girls in math and science classes, and indicated a lack of gender-balanced teaching initiatives in math and science classes. These results have broad implications for the lack of women in STEM disciplines, and they also reveal a potential means of classroom intervention to help counteract these subtle forms of bias.

**Keywords** STEM education · Gender role stereotypes · Self-efficacy · Gender-balanced teaching

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## 1 Introduction

The number of women in the United States who are pursuing careers in the fields of science, technology, engineering, and math (STEM) is dwarfed by the number of men pursuing STEM fields (Beede et al. 2011). The lack of women pursuing STEM fields has also gained international attention (e.g., Penner and CadwalladerOlsker 2012; Riegle-Crumb 2012). Research has indicated that more egalitarian countries show less of an achievement gap in mathematics between men and women, but women's interest in STEM still remains low with less women pursuing degrees or employment in STEM fields (Charles and Bradley 2002, 2009). One possible explanation for this disparity is gender bias, or a prejudice against girls and women in regard to their capabilities in STEM fields, that may lead people to view women's performance as inferior to men's in these fields. Recent research has shown that this is indeed the case. Both men and women tend to exhibit a subtle gender bias (i.e., there is little awareness of this bias) which favors men and coincides with traditional gender role stereotypes that portray women as less intellectually capable than men—particularly in STEM (Moss-Racusin et al. 2012; Reigle-Crumb and Humpries 2012). Research has also shown that these stereotypes implicitly shape behaviors that may lead individuals, including educators, colleagues, and administrators, to discriminate against women in STEM disciplines (Rice and Barth 2016).

Although these stereotypes provide a big impact in terms of shaping behavior, there is research indicating negligible differences between men and women in innate intellectual aptitude (Halpern 2013). In fact, girls tend to perform better academically than boys in mathematics and science courses (Shettle et al. 2007). Nevertheless, these stereotypes and the gender biases they impart may be preventing girls and women, who would otherwise excel in STEM disciplines, from pursuing appropriate education, employment, and career achievement. Despite programmatic efforts to correct this difference in men and women pursuing STEM, there is still a shortfall of girls and women pursuing STEM careers (National Science Foundation 2014); more research is necessary to continue to understand factors leading to this discrepancy.

Toward this end, researchers have studied gender biases and their effects in various stages of a woman's education and career. Of particular relevance to the current study is research that has focused on assessing the presence and impact of gender biases during adolescence and young adulthood. During this time, a student forms his or her identity, and part of this process includes career choice (Erikson 1994). These career choices can be greatly influenced by a student's adult role models and mentors, including teachers (Rice et al. 2013). Unfortunately, research has shown that teachers tend to exhibit gender biases which may be discouraging to girls that would otherwise be interested in STEM fields. For example, high school teachers tend to underestimate girls' mathematical abilities while overestimating boys' mathematical abilities (Fennema et al. 1990), and science professors at universities throughout the country have been shown to favor male applicants for a research assistant position in the sciences, even when identical applications from fictitious men or women were presented (Moss-Racusin et al. 2012). Given that adolescence and young adulthood are formative years for students' identity formation and career choice, it is possible that instructor biases may contribute to girls' tendency to perceive themselves as less capable in STEM fields.

To further explore these instructor biases, the current study was designed to investigate more subtle forms of gender biases, focusing on the biases tied to traditional gender role stereotypes, in high school teachers and students. In addition, the current study echoes previous literature by attempting to further document discrepancies in STEM self-efficacy between girls and boys in high school. This study adds to the body of literature examining gender bias in educational settings, where little research has been conducted focusing on gender role stereotype biases, particularly in teachers, that could unknowingly shape behavior.

### 1.1 Gender bias in STEM fields

Social Role Theory (Eagly 1987) stipulates that personality differences between men and women are derived from physical differences that led men and women to pursue different roles within society. For example, historically, men were needed to fill the roles of protector and provider of the family, which typically required characteristics that are commonly considered more masculine (e.g., competitive, adventurous). Conversely, women typically filled caretaker roles which required more characteristics often viewed as feminine (e.g., nurturing, sensitive). Though men and women are not necessarily tied to these historical roles, the characteristics associated with men and women have endured over time leading to differential expectations of the role of men and women in society (Eagly and Karau 2002). In an examination of these differential expectations, Moss-Racusin et al. (2015) recently examined online comments made on prominent news articles regarding gender bias in STEM fields and found that many people today still hold biased beliefs tied to traditional gender role stereotypes. The researchers observed explicitly stated discriminatory comments as well as individuals who attempted to justify the gender bias in STEM fields by arguing that natural differences between men and women offer a basis for discrimination. While the researchers acknowledged that online comments tend to be polarized, this research demonstrates that men and women are still tied to these expected gender roles.

The gender bias stemming from prescribed gender roles may be more likely to alter the experience of girls and women pursuing STEM disciplines. Gender role bias can be more understated and therefore, can influence actions and beliefs more easily since the perceiver is often unaware that these beliefs can shape their outward behavior. This issue is particularly relevant when considering STEM disciplines since STEM fields are often associated with more masculine characteristics (Carli et al. 2016). The norm violation of girls and women displaying masculine characteristics could cause backlash in the form of differential treatment. Research has shown that these gender role biases can affect a woman's career pursuits, largely based on the expectations of a perceiver. For example, Phelan et al. (2008) found that presenting women job applicants as more masculine could adversely affect how they are perceived. Specifically, women presented as more masculine tend to be viewed as more competent but less socially skilled which could affect women's advancement in their chosen career or discipline (Eagly and Sczesny 2009).

Much of the research in this area has focused on gender role bias in the workplace, but it seems likely that these biases could affect girls and women much earlier since gender role stereotypes have endured over time and are a learned association early in life. Teachers, much like employers, are likely to expect boys and girls to perform differently in STEM disciplines based on the characteristics they associate with being successful in these fields. These expectations could reinforce these gender role stereotypes for girls and also affect self-efficacy in disciplines misaligned with girls' prescribed gender role (e.g., STEM fields).

### 1.2 Student self-efficacy in STEM

Though studies that focus on gender role bias in education are very limited, there has been ample research examining the connection between girls' self-efficacy and interest in STEM career pursuits. Many researchers have indicated that a lack of self-efficacy in STEM disciplines contributes to the disparity between men and women pursuing these fields (e.g., Potvin et al. 2009). Research also suggests that women are more likely to experience lower levels of confidence if the common negative stereotypes associated with women in science and math are believed (Schmader et al. 2004; Stout et al. 2013). Further, Hazari et al. (2008) theorized that in addition to a confidence gap between girls and boys in STEM disciplines, girls may relate less to STEM subjects based on their prior experiences in the classroom.

Many studies indicate that teachers, mentors, and other adult role models are highly influential in students' self-efficacy and persistence in STEM disciplines. Bettinger and Long (2005) suggested that one obstacle for women seeking to join STEM fields is a lack of women role models in science. This impediment creates a harmful cycle in which women do not see themselves as scientists, and therefore, do not become role models for future girls pursuing science. With a lack of women role models in STEM, it seems likely that teachers play a pivotal role in providing encouragement for girls pursuing STEM. Moss-Racusin et al. (2012) argue that a teacher's assessment and perceived competence of a student is highly likely to contribute to the student's desire to pursue a scientific field. Rice et al. (2013) examined a large number of students at transition points from elementary school through early college. The researchers suggested that during these transition periods, such as late high school when students are making decisions about college, students make critical decisions about pursuing STEM disciplines. Further, these researchers found that teachers hold a substantial influence on students and reported that teacher support in math and science was correlated with increased student self-efficacy and positive perceptions of these fields.

### 1.3 The current study

Given that certain characteristics, those often tied to masculinity, have been shown to be associated with STEM disciplines, it is important to examine whether these same gender role biases affect educational settings. Previous research has shown that teachers play a significant role as a source of support for students, and that the school years are a time of identity formation for students making these years critical for personal and professional development. Gender role biases could unknowingly influence this development. Though much research has been conducted on gender role bias in the workplace, there is lack of this type of research in an educational setting. The current study sought to examine whether teachers tend to hold gender role biases toward STEM disciplines as an effort to expand the literature on gender role biases in educational settings.

Since the examination of possible gender role biases toward STEM disciplines is underrepresented in the literature, we also investigated gender role biases in the students. Further, we surveyed students near the end of grade eleven so that we could examine their biases and beliefs at a juncture where they were thinking about college. This was done in an effort to echo previous research examining lower self-efficacy in STEM subjects for girls. Finally, since other researchers have theorized that there are lack of women role models in STEM that could affect girls' interest in pursuing STEM (Bettinger and Long 2005), we asked students questions about the presentation of role models and other gender balanced teaching initiatives in their math and science courses.

It was hypothesized that teachers and students would show gender role biases in two ways. First, we expected teachers and students to indicate that more masculine characteristics are associated with the sciences and more feminine characteristics are associated with the humanities. This result would be consistent with Carli et al. (2016) who showed that masculine characteristics are often associated with STEM disciplines. Secondly, we expected teachers and students to indicate that boys perform better than girls in STEM disciplines, while girls perform better in the humanities. In addition, consistent with previous literature (Rice et al. 2013), girls were expected to indicate lower self-efficacy than boys in STEM subjects. Finally, students were expected to indicate less familiarity with women role models in their math and science courses.

## 2 Methods

### 2.1 Participants

A total of 44 teachers (28 women) and 121 students (61 girls) from one high school completed the current study. All students were in grade 11 since this is a critical time before making decisions on where to apply for college and selecting an expected college major. The majority of the participants indicated that they were White/Caucasian (86% of teachers, $n = 38$ and 80% of students, $n = 97$). Fifteen of the teachers indicated that they taught in a STEM discipline, 23 indicated that they taught in a humanities discipline, three teachers were part of the administration, and three did not indicate the area in which they specialize. Over half of the students (54.5%, $n = 66$, 28 girls) indicated that they were seeking to strongly focus their studies in STEM for the next coming academic year.

## 2.2 Measures and materials

Two sets of surveys were created, one for the teachers and one for the students. Both surveys included several items designed to examine gender role biases. The student survey also included an additional supplement examining self-efficacy and gender balanced teaching initiatives, such as presenting women role models in STEM classes.

To examine differences in perceptions of performance by subject area, both teachers and students were asked to indicate whether boys or girls perform better in a variety of STEM (e.g., biology, math) and humanities (e.g., English, history) disciplines. Participants were asked to respond on a 7-point scale ranging from 1 = boys are better to 7 = girls are better. The responses on appropriate items were then averaged to create a score for STEM subjects ($\alpha = .67$) and a score for humanities subjects ($\alpha = .53$). Though these alpha values seem low, these scales had a limited number of items. Cortina (1993) notes that Cronbach's alpha values can be dependent on the number of items in the scale and therefore, scales with fewer items can see lower reliability values.

Gender role biases were measured primarily by asking participants to identify how strongly masculine and feminine characteristics described a professional working in the sciences and a professional working in the humanities. The masculine and feminine characteristic items were derived from the Dimensions of Gender Role Stereotypes (Diekman and Eagly 2000). A modified 44-item version of this scale was used excluding the physical characteristic items and highlighting more job-related characteristics. Participants were asked to indicate how strongly they felt a person working in the specified profession (humanities or sciences) held each characteristic on a 5-point scale. These items were then averaged using the scoring criteria outlined in Diekman and Eagly (2000) to calculate an overall masculinity (sciences: $\alpha = .90$; humanities: $\alpha = .93$) and femininity (sciences: $\alpha = .95$; humanities: $\alpha = .92$) score plus six more masculinity/femininity scales (See Table 1 for reliability analysis).

### *2.2.1 Self-efficacy and gender balanced teaching*

The students also completed an additional supplement examining their self-efficacy in math and science similar to those questions asked in Rice et al. (2013) which

**Table 1** Reliability analysis for the six masculinity/femininity subscales for sciences and humanities

| Scale | Profession | |
|---|---|---|
| | Sciences | Humanities |
| Cognitive masculinity | .83 | .83 |
| Masculine personality | .82 | .82 |
| Negative masculinity | .89 | .89 |
| Cognitive femininity | .93 | .89 |
| Feminine personality | .78 | .72 |
| Negative femininity | .91 | .92 |

Responses were made on a 5-point scale where 1 indicates strongly disagree and 5 indicates strongly agree were adapted from the Michigan Study of Adolescent and Adult Life Transitions (2006). Four items were presented in each of the subjects, math and science, and then averaged to create a self-efficacy score for each discipline. These items asked students to rate their performance in math and science courses and examined their comfort level doing math and science (math self-efficacy: $\alpha = .78$; science self-efficacy: $\alpha = .73$). All items were presented with a 7-point scale, 1 = strongly disagree to 7 = strongly agree. Finally, students were asked a series of questions examining their perception of gender balanced teaching initiatives. These items asked the students whether they learned about people using these subjects in the real world and whether they learned about women role models in each of these disciplines. These were individual questions and therefore, no data transformation was conducted.

### 2.3 Procedure

Ethical approval to administer surveys was obtained from the school where this research was conducted. Informed consent letters were given to teachers and student's parents at least 2 days prior to survey administration. Next, the researcher administered the surveys to those willing to participate. The teachers completed the surveys on their own time and were asked to return the survey packet anonymously to a central location. The students completed the survey during regularly scheduled study hall. All surveys were kept anonymous to protect participant identity, and to ensure participants could feel comfortable expressing their opinions.

## 3 Results

### 3.1 Gender role bias based on perceived characteristics

To examine gender role bias based on perceived masculine and feminine characteristics, teachers and students were asked to indicate to what degree they believed each characteristic from the modified Dimensions of Gender Role Stereotypes (GRS; Diekman and Eagly 2000) measure represented individuals working in the sciences or humanities. It was hypothesized that both teachers and students would show gender role biases by indicating that masculine characteristics are associated more highly with someone working in the sciences and that feminine characteristics are associated more highly with someone working in the humanities. The follow analyses were designed to test these predictions.

#### *3.1.1 Teacher data*

The dimension scores of the modified GRS were prepared for analysis in the manner prescribed by the developers of the scale (Diekman and Eagly 2000; i.e., as the average of relevant scale items) yielding six different scales: cognitive masculinity/femininity, masculine/feminine personality, and negative masculine/feminine characteristics. Overall masculinity and overall femininity were each computed as the average of three relevant dimensions. These overall GRS scores were the first to be analyzed. A 2 (discipline: science and humanities) × 2 (GRS component: masculinity or femininity) repeated measures ANOVA indicated a significant interaction, $F(1, 42) = 34.89$, $p < .001$, $\eta_p^2 = .45$ (Fig. 1). This interaction was dissected using pairwise comparisons, which revealed that teachers reported a stronger association between masculine characteristics and STEM disciplines and feminine characteristics with someone who works in the humanities.

A subsequent 2 (discipline) × 6 (GRS dimension) repeated measures ANOVA was conducted. Discipline and GRS dimension factors interacted significantly, $F(2.78, 116.94) = 23.87$, $p < .001$, $\eta_p^2 = .36$. This interaction appeared to reflect the teachers' gender role biases by associating STEM professionals more strongly with masculine cognitive characteristics (e.g., analytical; $p < .05$) and masculine personality characteristics (e.g., competitive; $p = .07$, marginal). In addition, the teachers associated humanities professionals with feminine cognitive characteristics (e.g., creative, $p < .05$) and feminine personality characteristics (e.g., nurturing, $p < .05$). Teachers did not differentially associate STEM and humanities professionals with either masculine negative characteristics (e.g., egotistical, greedy, dictatorial) or feminine negative characteristics (e.g., submissive, gullible, complain too much). See Fig. 2 for a graphical representation of these analyses. The mean ratings for the GRS dimension factor were also significant, $F(1.74, 72.91) = 9.48$, $p < .001$, $\eta_p^2 = .18$; and this result was ignored due to the interaction described above.

### *3.1.2 Student data*

To assess the possibility of gender role biases in students, we first examined overall GRS masculinity or femininity by discipline. A 2 (student sex; between subjects) × 2 (discipline: science or humanities; within subjects) × 2 (GRS type: overall masculinity or femininity; within subjects) mixed-model ANOVA was used to examine these overall GRS scores, revealing a significant interaction between discipline and GRS type, $F(1, 118) = 209.79$, $p < .001$, $\eta_p^2 = .64$ (Fig. 3). Follow up analyses indicated that when students were assessing characteristics relevant for

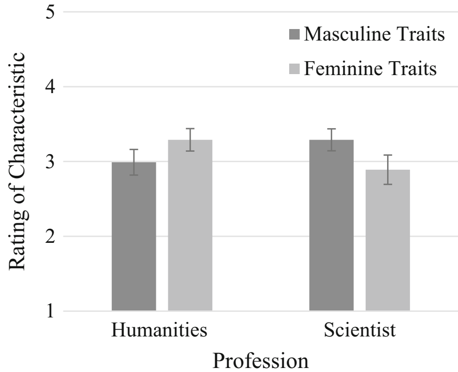



**Fig. 1** The interaction between profession and overall GRS masculinity/femininity for teacher data showing that teachers significantly prescribed masculine traits to a greater degree to someone working in the sciences and feminine traits to a greater degree to someone working in the humanities. Error bars represent standard errors

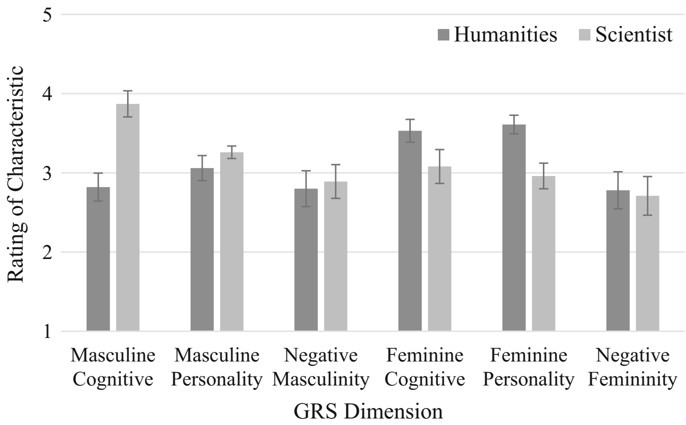
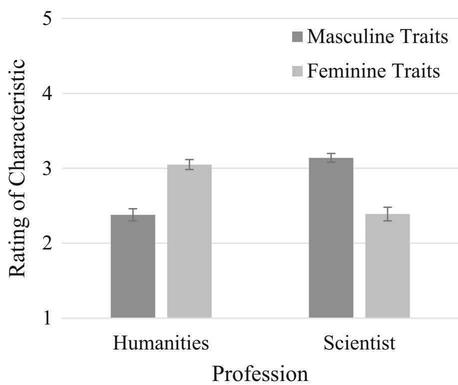



**Fig. 2** Analysis of the six GRS dimensions and how a professional in the humanities or sciences was rated by teachers. Error bars represent standard errors

someone working in the sciences, they were more likely to indicate masculine characteristics were associated with this discipline. However, professionals working in the humanities were viewed as holding more feminine characteristics. All other potential main effects and interactions were not significant, $p > .05$.

A more nuanced look at these gender role biases was accomplished by analyzing characteristic associations for each of the six GRS dimensions for someone working in the sciences or humanities. A 2 (student sex) × 2 (discipline: science and humanities) × 6 (GRS dimension) mixed-model ANOVA was conducted. This analysis was corrected for sphericity violations using Box's epsilon (Maxwell and Delaney 2004). The results of this analysis mirrored those of the previous analysis of overall GRS masculinity and femininity. The discipline factor interacted significantly with the GRS dimension factor, $F(2.99, 353.24) = 135.27$, $p < .001$, $\eta_p^2 = .53$. Follow up pairwise comparisons revealed that each of the masculine dimensions (cognitive, personality, and negative) was associated more strongly with STEM fields than with humanities in each case. In contrast, the feminine dimensions

**Fig. 3** The interaction between profession and overall GRS masculinity/femininity for student data showing that students significantly prescribed masculine traits to a greater degree to someone working in the sciences and feminine traits to a greater degree to someone working in the humanities. Error bars represent standard errors



(cognitive, personality, and negative) were more strongly associated with the humanities fields than the STEM fields in each case (Fig. 4). The ANOVA also indicated that there were significant differences in ratings among the GRS dimensions, $F(2.57,\ 300.53) = 25.66$, $p < .001$, $\eta_p^2 = .18$. However, the main effect of GRS dimensions was not evaluated due to the involvement of that factor in the interaction described above. All other potential main effects and interactions were not significant, $p > .05$. Taken together, these analyses support our hypothesis that students would show a gender role bias by attributing more masculine characteristics to a scientist and more feminine characteristics to someone who works in the humanities. Further, these analyses indicate that boys and girls did not demonstrate different gender role biases, instead both genders were inclined to show the same bias.

## 3.2 Gender role bias based on performance

Both teachers and students were expected to indicate that boys perform better in STEM disciplines, while girls perform better in humanities disciplines. Responses to these items were averaged across STEM and humanities disciplines listed in the survey and then several analyses were used to examine differences in the perception of how girls and boys perform. In these and all subsequent analyses, an alpha of .05 was employed and the Bonferroni correction was used to control Type I error when multiple statistical comparisons were conducted.

### *3.2.1 Teacher data*

We began by determining whether teachers held any significant gender role biases in regard to STEM or humanities disciplines. A pair of single sample *t* tests were used to determine whether the overall mean was significantly different from the midpoint of the scale used for this measure (i.e., a value of 4 on the 7-point scale

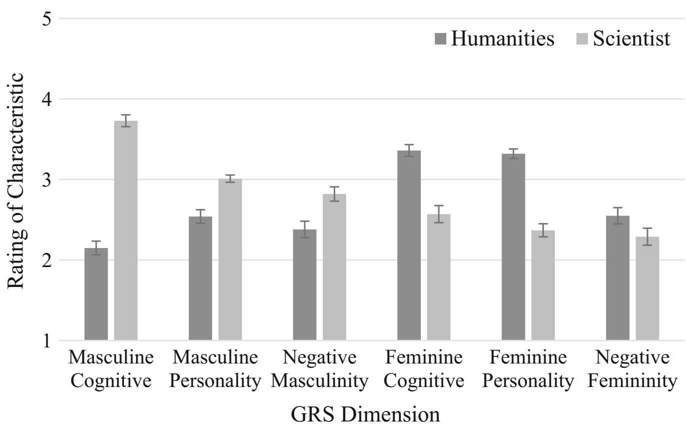



**Fig. 4** Analysis of the six GRS dimensions and how a professional in the humanities or sciences was rated by students. Error bars represent standard errors

presented to participants). Failure to reject the null hypothesis for either STEM or humanities disciplines would have indicated that there is no significant gender role bias for that discipline since the lower end of this scale signified boys perform better and the higher end of this scale signified girls perform better with a midpoint of four indicating no gender difference in performance. Conversely, these analyses did reveal significant gender role biases. On average, teachers reported that boys are better at STEM subjects ($M = 3.57$, $SE = 0.08$), $t(42) = 5.44$, $p < .001$; and that girls are better at humanities subjects ($M = 4.27$, $SE = 0.07$), $t(42) = 3.68$, $p = .001$.

This analysis was followed with a single factor (discipline: STEM and humanities) repeated-measures Analysis of Variance (ANOVA) to examine whether teachers' believed that boys and girls are differentially skilled in STEM disciplines and humanities disciplines. Teachers had a tendency to report that boys are superior in STEM disciplines ($M = 3.57$, $SD = .53$), whereas girls were better at humanities disciplines ($M = 4.25$, $SD = .47$), $F(1, 42) = 26.41$, $p < .001$, $\eta_p^2 = .39$. This result supports the hypothesis that teachers would show a gender role bias by indicating that boys perform better in STEM disciplines, while girls are perceived to perform better in humanities subjects.

#### 3.2.2 Student data

As with the previous analysis of teachers' gender role bias, we began analyses of student gender role bias with a pair of one-sample *t* tests to determine whether students reported that either boys or girls are significantly better at STEM or humanities disciplines. On average, students believed that boys are better at STEM disciplines ($M = 3.55$, $SE = 0.05$; lower numbers meaning that the participants thought boys perform better), $t(121) = 8.72$, $p < .001$; and that girls are better at humanities disciplines ($M = 4.24$, $SE = 0.06$), $t(121) = 4.16$, $p < .001$.

Given clear evidence for gender role biases, student responses to this scale were analyzed further using a 2 (student sex; between subjects) × 2 (discipline: STEM and humanities; within subjects) mixed-model ANOVA. Similar to the above analysis, this analysis showed that the mean rating for STEM disciplines was significantly different from the mean rating for humanities disciplines, $F(1, 118) = 98.13$, $p < .001$, $\eta_p^2 = .45$. There was also a marginal effect of student sex, $F(1, 118) = 3.71$, $p = .057$, $\eta_p^2 = .03$. Boys ($M = 3.81$, $SE = 0.06$) and girls ($M = 3.97$, $SE = 0.06$) were relatively biased towards rating their own sex as being better at STEM subjects and humanities subjects. It should be noted, however, that despite this relative bias, mean ratings from neither boys nor girls appeared to favor girls as being academically superior. The interaction between the participant sex and discipline factors was not significant, $p > .05$.

To further examine this issue of gender role biases in students, we considered whether students thought certain disciplines were more useful for boys than girls. Independent samples *t* tests were used to examine gender differences in students' ratings of the usefulness of math and science subjects. Boys, more so than girls, reported that math, $t(118) = 2.02$, $p = .05$ (marginal); and science, $t(118) = 2.50$, $p = .03$, are of greater utility to boys than girls (See Table 2 for means). Overall,

**Table 2** Means depicting whether students think math or science is more useful for boys or girls

| | Participant gender | |
|---|---|---|
| | Boy | Girl |
| Subject area | | |
| Math | 2.10 (*SD* = 1.55) | 1.59 (*SD* = 1.2) |
| Science | 2.07 (*SD* = 1.68) | 1.43 (*SD* = 1.06) |

Responses were made on a 7-point scale where 1 indicates strongly disagree and 7 indicates strongly agree

these results support our hypothesis by indicating that students have a tendency to indicate that boys perform better in STEM subjects while girls perform better in humanities subjects.

### 3.3 Student self-efficacy and classroom climate

Consistent with previous research (e.g., Rice et al. 2013), we expected gender differences in student-reported self-efficacy for STEM subjects. A 2 (student sex) × 2 (subject: math and science) ANOVA was used to examine gender differences. Through this analysis, it was discovered that girls rated themselves as significantly less competent than boys in both mathematics, $F(1, 118) = 12.87$, $p < .001$, $\eta_p^2 = .10$, and science, $F(1, 118) = 5.38$, $p = .02$, $\eta_p^2 = .04$ (Fig. 5).

Since previous literature has identified role models as a strong source of support for girls pursuing STEM (e.g., Bettinger and Long 2005), we also examined the presentation of role models in math and science courses. To examine the presentation of real-world applicable examples for boys and girls, students were asked to rate how often that occurs in the classroom in both math and science. A 2 (discipline) × 2 (student sex) one-way ANOVA was used to examine gender differences in these ratings. Girls ($M = 3.97$, $SD = 1.95$) were less likely to indicate that they learned about real people using science, $F(1, 118) = 7.56$, $p < .01$, $\eta_p^2 = .06$, than boys ($M = 4.59$. $SD = 1.66$). Interestingly, both boys ($M = 2.56$, $SD = 1.63$) and girls ($M = 1.89$, $SD = .98$) indicated similar low

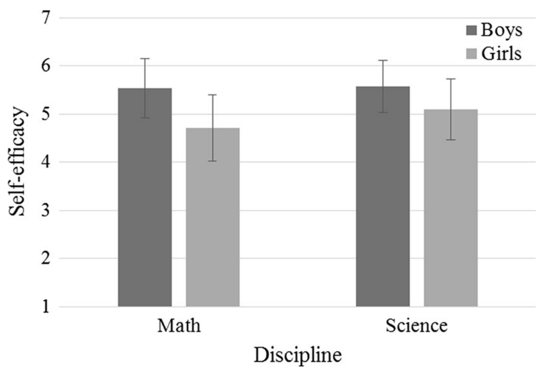



**Fig. 5** Self-efficacy ratings of boys and girls in math and science classes. Error bars represent standard errors

levels of learning about real people that do math outside the classroom, $F(1, 118) = 3.57$, *ns*.

Students were also asked specifically whether they had learned about female mathematicians and scientists. A 2 (student sex) × 2 (discipline) was conducted to examine whether boys and girls recall their classroom experiences differently. In math, the area in which girls report the lowest self-efficacy, girls ($M = 1.54$, $SD = .99$) were less likely than boys ($M = 2.07$, $SD = 1.47$) to indicate learning about female mathematicians, $F(1, 118) = 5.31$, $p = .02$, $\eta_p^2 = .04$. Boys and girls were equally likely to report learning about female scientists, $F(1, 118) = 2.21$, *ns*. Taken together, these results suggest that girls and boys perceive less exposure to real world people working in math and science, particularly lacking in women role models in these fields.

## 4 Discussion

The current study examined whether teachers and students held gender role biases affecting how they view the pursuit of STEM disciplines by boys and girls. Consistent with the hypotheses, results indicated that both teachers and students reported the perception that boys perform better in STEM disciplines, while girls perform better in humanities disciplines. In addition, also consistent with our hypotheses, the data showed that both teachers and students attributed more masculine characteristics to someone working in the sciences and more feminine characteristics to someone working in the humanities. Our survey went further to replicate the documented self-efficacy discrepancy between boys and girls in STEM performance, and asked students about specific gender-balanced teaching initiatives in the classroom since role models likely play a significant role in girls' pursuit of STEM. Similar to previous literature, there was a significant confidence gap between boys and girls, with girls reporting lower self-efficacy in math and science. Girls and boys also reported different perceptions of gender-balanced teaching initiatives, with girls reporting less familiarity with women role models highlighted in math class. Boys and girls reported equally low familiarity with women role models presented in science courses.

Gender role biases toward STEM disciplines are often found anecdotally, and recently, research has highlighted this bias empirically (Carli et al. 2016). Our study provides evidence that teachers, an important role model for adolescents and young adults, can also hold these same biases. This is an important issue because the results of this study highlight that certain characteristics are perceived to be important to succeeding in STEM disciplines in an educational setting. Unfortunately, these same characteristics are also more often associated with boys and men than girls and women. It seems likely that these gender role biases may affect a teacher's behavior toward students. For example, previous research has shown that teachers can differentially perceive the abilities of girls and boys in math (Fennema et al. 1990), and this likely creates differential treatment in the form of encouragement, praise, or even passing the student to the next level of math or science. Interestingly, though there is empirical evidence showing that girls tend to perform better in math and science than boys (Shettle et al. 2007), the teachers in the current study indicated the opposite, perceiving boys as performing better in these subjects. This is likely a misperception due to these gender role biases and ingrained beliefs that girls may not have the characteristics necessary to be successful in STEM disciplines.

The students also held gender role biases that affected their view of boys and girls in STEM disciplines. These gender role biases could be influencing the students' confidence in their abilities, particularly if they do not feel that they hold the appropriate characteristics perceived to be important for STEM. In addition, students might be concerned about potential backlash if they pursue STEM disciplines. Role Congruity Theory (Eagly and Karau 2002) suggests that when people act counter to the gender role prescribed for their own gender, there could be negative consequences. Since society, teachers included, tends to associate STEM with masculine characteristics, a girl performing well in STEM or having a desire to pursue STEM could be subject to negative consequences and differential treatment. Previous research has identified teacher support as a source of increased self-efficacy in STEM subjects for girls (Rice et al. 2013), and therefore, this differential treatment stemming from gender role biases of teachers and students, could discourage positive self-efficacy in these fields.

The current study echoed this previous study by demonstrating a confidence gap between girls and boys in math and science. Furthering this discussion, we examined perceptions of the presentation of role models other than teachers in math and science classes. Boys were more likely to indicate that they learned about real people using science outside the class, but both boys and girls indicated a lack of examples of real people using math outside the classroom. Examining presentation of women role models specifically, girls were less likely to indicate that they had learned about female mathematicians in math class, and both boys and girls indicated that there was a lack of education about female scientists in science class. Clearly, girls are perceiving less presentation of role models relevant to their math and science education and this is an issue since previous research has discussed the importance of women role models in math and science for girls wanting to pursue these fields (Bettinger and Long 2005). A simple classroom change aimed at closing the confidence gap could be balancing these discrepancies by incorporating a variety of role models and examples relevant to boys and girls in math and science courses.

### 4.1 Limitations and future directions

One limitation of the current study is the nature of the student sample. While the sample was well-distributed among girls and boys, it was not racially diverse, and increased diversity could have added to the insight gained from this data. Also, the self-report nature of this survey raises concerns about socially desirable responding which would limit the conclusions that can be made from this study. However, we would expect that it would be socially desirable to indicate that girls and women can pursue any field, including STEM. Yet, our results revealed a bias, which alleviates some of the concerns about socially desirable responding. Finally, all participants for the current study attended or worked at an academically rigorous high school which emphasizes STEM education, so these results may not reflect the biases and opinions of teachers and students at other high schools. While this may be considered a limitation, we would actually argue this is a strength of the current study. Considering this was an academically rigorous high school, the majority of students plan on attending a 4-year university after graduation and therefore, these results are likely to extend to other students seeking to attend a 4-year university. Further, since this school emphasizes STEM pursuits, it seems likely that these results will also generalize to schools that place less of an emphasis on STEM. The teachers in the current study work with a larger number of girls seeking to pursue STEM than a traditional high school and therefore, it could be assumed that these teachers would hold less bias due to exposure. Finally, the effects of gender role stereotypes have been shown to endure over time and be universal across cultures, so it is expected that regardless of the sample used, these results will likely generalize.

This study adds to the body of literature concerning gender role biases and STEM disciplines in education, though there are additional questions that should be pursued to further understand these issues. First, it would be interesting to understand the direct relationship between teacher gender role biases and students' confidence in their STEM abilities. Our study examined both of these concepts, but our dataset did not lend itself to addressing this concern. In addition, a more longitudinal approach to examining self-efficacy change throughout schooling could provide better insight into when the confidence gap and gender role biases develop. Finally, more programmatic research designed to examine changes in the classroom environment seems necessary. Highlighting more real world people using math and science, including more women role models could impact girls' self-efficacy in STEM subjects and also lessen the effects of gender role bias in the classroom.

## 4.2 Conclusions

This research provides further evidence that gender role biases can govern both teacher and student perceptions of STEM subjects. This research also contributes to the understanding of specific factors related to gender role biases such as student self-efficacy and the presentation of role models in math and science classes. Teacher biases and the presentation of role models in critical courses are under-examined areas, and our research presents opportunities for classroom and behavior change. Issues were identified within each of these areas, suggesting opportunities for intervention in order to mitigate obstacles presented by these gender role biases. The goal of these interventions would be to diminish the effect of these gender role biases in the classroom and increase the number of girls and women who desire to pursue STEM professions.

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**Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

## References


Beede, D., Julian, T., Langdon, D., McKitrick, G., Khan, B., & Doms, M. (2011). Women in STEM: A gender gap to innovation. *Economics and Statistics Administration Issue Brief, 4*(11), 1–11.

Bettinger, E. P., & Long, B. T. (2005). Do faculty serve as role models? The impact of instructor gender on female students. *Understanding Teacher Quality, 95*(2), 152–157.

Carli, L. L., Alawa, L., Lee, Y., Zhao, B., & Kim, E. (2016). Stereotypes about gender and science women ≠ scientists. *Psychology of Women Quarterly, 40*(2), 244–260. doi:10.1177/0361684315622645

Charles, M., & Bradley, K. (2002). Equal but separate? A cross-national study of sex segregation in higher education. *American Sociological Review, 67,* 573–599.

Charles, M., & Bradley, K. (2009). Indulging our gendered selves? Sex segregation by field of study in 44 countries. *American Journal of Sociology, 114,* 924–976.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Psychometrika, 16,* 297–334.

Diekman, A. B., & Eagly, A. H. (2000). Stereotypes as dynamic constructs: Women and men of the past, present, and future. *Personality and Social Psychology Bulletin, 26*(10), 1171–1188.

Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Eagly, A. H., & Karau, S. J. (2002). Role congruity theory of prejudice toward female leaders. *Psychological Review, 109,* 573–598.

Eagly, A. H., & Sczesny, S. (2009). Stereotypes about women, men, and leaders: Have times changed? In M. Barreto, M.K. Ryan, & M.T. Schmitt (Eds.), *The glass ceiling in the 21st century: understanding barriers to gender equality* (pp. 21–47). Washington, DC: American Psychological Association.

Erikson, E. H. (1994). *Identity: Youth and crisis (No. 7)*. New York City, NY: WW Norton & Company.

Fennema, E., Peterson, P. L., Carpenter, T. P., & Lubinski, C. A. (1990). Teachers' attributions and beliefs about girls, boys, and mathematics. *Educational Studies in Mathematics, 21,* 460–507.

Halpern, D. F. (2013). *Sex differences in cognitive abilities*. Hove: Psychology Press.

Hazari, Z., Sadler, P. M., & Tai, R. H. (2008). Gender differences in the high school and affective experiences of introductory college physics students. *The Physics Teacher, 46*(7), 423–427.

Maxwell, S. E., & Delaney, H. D. (2004). *Designing experiments and analyzing data: A model comparison perspective* (Vol. 1). Hove: Psychology Press.

Michigan Study of Adolescent and Adult Life Transitions. (2006). *University of Michigan Gender and Achievement Research Program*. Retrieved from http://www.rcgd.isr.umich.edu/msalt.

Moss-Racusin, C. A., Dovido, J. F., Brescoll, V. L., Graham, M. J., & Handlesman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences, 109*(41), 16474–16479.

Moss-Racusin, C. A., Molenda, A. K., & Cramer, C. R. (2015). Can evidence impact attitudes? Public reactions to evidence of gender bias in STEM fields. *Psychology of Women Quarterly, 1*(16), 1–16.

National Science Foundation. (2014). *Science and engineering indicators.* Retrieved from http://www.nsf.gov/statistics/seind14/.

Penner, A., & CadwalladerOlsker, T. (2012). Gender differences in mathematics and science achievement across the distribution: What international variation can tell us about the role of biology and society. In F. D. Rivera & H. Forgasz (Eds.), *Toward equity in mathematics education: Gender, culture, and diversity* (pp. 441–468). New York: Springer.

Phelan, J. E., Moss-Racusin, C. A., & Rudman, L. A. (2008). Competent yet out in the cold: Shifting criteria for hiring reflect backlash toward agentic women. *Psychology of Women Quarterly, 32*(4), 406–413.

Potvin, G., Hazari, Z., Tai, R. H., & Sadler, P. M. (2009). Unraveling bias from student evaluations of their high school science teachers. *Science Education, 93*(5), 827–845.

Reigle-Crumb, C., & Humpries, M. (2012). Exploring bias in math teachers' perceptions of students' ability by gender and race/ethnicity. *National Institute of Health and Public Access, 26*(2), 1–17.

Rice, L., & Barth, J. M. (2016). Hiring decisions: The effect of evaluator gender and gender stereotype characteristics on the evaluation of job applicants. *Gender Issues, 33*(1), 1–21.

Rice, L., Barth, J. M., Guadagno, R. E., Smith, G. P. A., & McCallum, D. M. (2013). The role of social support in student's perceived abilities and attitudes toward math and science. *Journal of Youth and Adolescence, 42*(7), 1028–1040.

Riegle-Crumb, C. (2012). The cross-national context of the gender gap in math and science. In L. Hedges & B. Schneider (Eds.), *The social organization of schools* (pp. 227–243). New York: Russell Sage Press.

Schmader, T., Johns, M., & Barquissau, M. (2004). The costs of accepting gender differences: The role of stereotype endorsement in women's experience in the math domain. *Sex Roles, 50*(11–12), 835–850.

Shettle, C., Roey, S., Mordica, J., Perkins, R., Nord, C., Tedorovic, J., et al. (2007). *The nation's report card: America's high school graduates. Results from the 2005 NAEP High School Transcript Study.* Washington, DC: National Center for Education Statistics. Retrieved from http://nces.ed.gov/nationsreportcard/pdf/studies/2007467.pdf.

Stout, J. G., Ito, T. A., Finkelstein, N. D., & Pollock, S. J. (2013). How a gender gap in belonging contributes to the gender gap in physics participation. In *AIP conference proceedings* (Vol. 1513, No. 1, pp. 402–405).

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