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# Interventions to Increase STEM Retention of Undergraduate Women: A Literature Review

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## Introduction

- The lack of women in STEM contributes to a large proportion of the gender wage gap and creates a deficiency of diverse perspectives within STEM fields (Schmader, 2023). This generates an urgency to increase the retention of women in STEM majors.
- Many psychological constructs are important to predicting women's STEM performance and retention. For example:
  - *Self-efficacy* is an individual's belief in their capacity to act in the ways necessary to reach specific goals. Self-efficacy acts jointly with outcome expectations to lead to interests, and in turn career choices (Lent et al., 1994, 2000, 2015).
  - *Belonging* is a sense of fit with a major, and underrepresented minorities lacking a sense of belonging are more likely to have low self-efficacy and are therefore less likely to persist in STEM majors (Fouad and Santana, 2017).
  - *Stereotypes* can be directly internalized to shape beliefs about oneself. For example, if one holds the stereotypic association of math ≠ female and the implicit identification of self = female, then one will likely possess an implicit self-stereotypic association of self ≠ math (Schmader, 2023). These negative stereotypic associations with oneself can reduce the self-efficacy of a student if they believe they are incapable of success.
- Interventions attempt to directly influence these and other psychological constructs to increase women's STEM persistence.

## Research Questions

1. What **kinds of interventions** have targeted the retention of women in STEM majors?
2. Which have **been the most successful** at improving the retention of women in STEM?

## Search Methods

- Total studied included = 26
- Search engines: PsycINFO and Google Scholar
- Study inclusion criteria: experimental or quasi-experimental design; college student sample; peer-reviewed; published in the past 15 years
- Key terms: women in STEM self-efficacy, performance, sense of belonging, identification, interest, retention, STEM stereotypes and implicit gender biases

## Recommendations

- The most successful kinds of interventions that colleges should implement are those that provide women positive female role models and positive interactions with their STEM peers.
- STEM majors should not be misleading about the potential biases and underrepresentation that women and BIPOC students may face in STEM, but drawing attention to the problem of bias must be paired with positive examples of successful scientist role models so as not to push women and BIPOC students from STEM.

## Acknowledgements

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## Results

### *Intervention Type 1: Role Models and Faculty Mentors*

**Intervention success: Successful.** Providing women in STEM with positive female role models and faculty mentors has increased women students' performance, STEM identity, attitudes, belonging, and self-efficacy, and reduced implicit stereotypes (Shapiro et al., 2013, Crane et al., 2022, van Camp et al., 2019, Kuchynka et al., 2023, Herrmann et al., 2016, Zhang & Rios, 2023).

**Example study:** In a study conducted by Herrmann et al. (2016), 68 female undergraduate students enrolled in an introductory chemistry course were given a letter from a female graduate student who served as a role model to the participants. The letter from the role model normalized concerns about belonging, presented time spent on academics as an investment, and exemplified overcoming challenges on academic performance and persistence. Relative to the control group, the intervention group which read the letter from the role model had higher course grades and lower course withdrawal rates.

### *Intervention Type 2: Peer Relationships and Communal Perceptions*

**Intervention success: Successful.** Interventions to foster positive peer relationships and expand communal perceptions of women in STEM have been shown to increase STEM self-efficacy, interest, persistence, and positive attitudes (Pietri et al., 2021, Szeléyni et al., 2013, Allen et al., 2021, Diekman et al., 2011).

**Example Study:** Allen et al. (2021) conducted an experiment to test the effects of peer relationships on communal goal perceptions and STEM persistence. A female student was paired with another student and completed a "getting-to-know-you" activity. After completing the activity, they were asked to execute a data transcription task made to mimic real-life research tasks. Students who completed the get-to-know-you activity persisted longer in the data task, reported more agreement with communal goals, and more interest in science than students who had not gotten to know their partner.

### *Intervention Type 3: Environmental Aspects*

**Intervention success: Successful, but few studies.** Interventions to create gender-neutral STEM environments or altering STEM environments to contain more women-in-STEM identifiers have been shown to increase STEM interest and reduce stereotypic associations (Cheyran et al., 2009, Ramsey et al., 2013).

**Example Study:** An experiment conducted by Cheyran et al. (2009) tested the effects of objects in a computer science classroom on interest in computer science in undergraduate non-computer science majors. Researchers found that changing the objects in a computer science classroom from masculine stereotypical objects (e.g., Star Trek posters, video games) to non-masculine-stereotypical objects (e.g., nature posters, phone books) boosted female undergraduates' interest in computer science to the level of their male peers. Male participants' interest in computer science was not reduced when exposed to the same two environments. This suggests that classroom objects can represent the stereotypes of a group, which can dissuade those who do not identify with these stereotypes from becoming a member of the group.

### *Intervention Type 4: Gender Bias Awareness*

**Intervention success: Mixed success.** Interventions that inform women in STEM and BIPOC students in STEM that they may encounter bias or stereotypes have mixed success in promoting positive outcomes. Awareness of gender bias and gender stereotypes predicted greater intent to leave one's job and less work engagement (Reilly et al., 2019), lower psychological well-being and lower science performance (Settles et al., 2016), and higher expectations for discriminatory treatment in the future in BIPOC students and White students (Casad et al., 2019).

**Example Study:** In a sample of 505 college women, Pietri et al. (2018) found that delivering information about the gender bias with an article about a successful woman scientist role model increased students' beliefs that women in science encounter bias but also encouraged students' identification with that female scientist. Participants reported greater interest in taking classes with and working on research with the woman scientist in the gender bias information condition.

### *Intervention Type 5: Growth Mindset*

**Intervention success: Mixed success.** A growth mindset is the belief that ability can be grown by exerting effort, seeking help from others, and revising strategies in the face of challenges. Interventions demonstrated mixed success in targeting outcomes such as GPA, completion of course credits (Broda et al., 2018), academic performance and attitudes (Wang et al., 2021), final course score (Hoang et al., 2018), and other outcomes.

**Example Study:** Broda et al. (2018) provided 6,529 college students a series of eight weekly sessions in which students learned about the function of the brain and how the brain could become stronger by taking on challenges. Latino/a students in the mindset treatment group had significantly higher GPAs for both the fall semester and the spring semester as well as a higher cumulative GPA after their first year of classes. However, White and African American students reported no significant differences.