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STEM by the Lake: Raising High School Women's Engineering Self-Efficacy and Belongingness through an Educational Intervention about Water Issues and Careers

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ABSTRACT
Women tend to have lower interest in engineering as compared to men, which previous research has shown is partly explained by gender differences in self-efficacy, social belongingness and communal career goals. Therefore, to attract more women to engineering, effective interventions are needed that target these factors. In this study, we evaluated an industry-designed intervention for high school students. The intervention consisted of a two-day interdisciplinary course on water issues and careers in the water sector, located by a lake in the Swedish countryside. The participating 722 high school students answered a survey before, immediately after, and three months after the intervention. We measured interest, self-efficacy, social belongingness, communal career goal affordance, and stereotype threat, in relation to engineering. The results showed expected gender differences in all pre-measures. A promising result was that the intervention raised women's engineering self-efficacy and social belongingness and reduced stereotype threat levels. However, repeated exposure might be necessary for the changes to last. Engineering interest was unexpectedly not affected by the intervention, which may imply that stronger increases in self-efficacy and social belongingness are necessary to impact interest.

KEYWORDS
Engineering; STEM; intervention; self-efficacy; social belongingness; communal career goals; gender differences

STEM by the Lake: Raising High School Women's Engineering Self-Efficacy and Belongingness through an Educational Intervention about Water Issues and Careers

INTRODUCTION

Many occupations in the STEM field (Science, Technology, Engineering and Mathematics) are still heavily gender-skewed and dominated by men, despite continuous efforts to attract more women to the field. For example, in the US, only 15% of engineers are women (United States Census Bureau, 2021) and in Sweden, where the data for this study was collected, the proportion is 25% (Statistics Sweden, 2020). That so few women choose to study engineering may be seen as a problem for individual women who miss out on opportunities for potential careers that could fit them well, but also for employers. The STEM sector is already facing a global shortage of skilled labor, which is expected to grow (Nordic Council of Ministers, 2021; Shoffner & Dockery, 2015; Swedish Public Employment Service, 2022). Attracting women to STEM is therefore important for securing the future workforce (Nordic Council of Ministers, 2021). The EU Institute for Gender Equality (EIGE) estimates that closing the gender gap in STEM would increase economic growth in the EU by an additional €610-820 billion by 2050, due to reduced labor market shortages and increased productivity (EIGE, 2017).

To counteract these problems, the STEM industry often designs activities for children and youth, where one aim is to increase interest in the field. One limitation of these efforts is that they are rarely scientifically evaluated, and we therefore lack insight into their effectiveness (Shoffner & Dockery, 2015; Valla & Williams, 2012). In this study, we empirically investigate the effectiveness of such an industry-financed intervention for high school students called *Think H_2O*, which takes place at a lake in the Swedish countryside. For two full days, the students learn about water and sustainability issues and about careers in the water sector, including engineering.

We test the potential effect of the industry intervention on the students' interest in engineering and on predictors of gender differences in engineering interest, namely engineering self-efficacy, social belongingness and perceived communal career goal affordance in engineering. We will next describe the theoretical basis of these predictors. We also study the potential effect of the intervention to reduce young women's stereotype threat for engineering. Stereotype threat is typically not related to interest but according to stereotype threat theory, it is linked to an increased risk of disengaging from a field despite interest (Spencer et al., 2016; Steele, 1997; Steele & Aronson, 1995).

Theories of Gender Differences in Career Interest

Although some still believe that the gender skewness in engineering relates to psychological gender differences in ability (see Saini, 2017 for a review) empirical data does not support this view. Abilities that are relevant for the STEM sector, such as mathematical skill, typically show gender similarity, or are even counter-stereotypically to girls' advantage (Ceci et al., 2009; Hyde et al., 2019). For example, in the 2018 US National Assessment of Educational

Progress, eighth grade girls outperformed boys in all areas of technology and engineering literacy (US Department of Education, 2018). However, girls tend to underestimate their STEM abilities, while boys sometimes overestimate them, and this may relate to gender stereotypes (Bench et al., 2015; Watt, 2010). Much research has shown that around the world, people implicitly associate science, math and more recently technology with men (Master et al., 2017; Miller et al., 2015; Shin et al., 2016; Tellhed et al., 2022). In Sweden, children also tend to explicitly state that they believe that men are better at technology than women (Tellhed et al., 2022). Gender stereotypes can affect the development of career interest both directly (Spencer et al., 2016; Steele, 1997; Steele & Aronson, 1995; Tellhed et al., 2022) and indirectly, through affecting the development of theoretically derived predictors of STEM interest.

There are two main psychological theories that describe predictors of career interest and career choice. Social cognitive career theory (SCCT; Lent et al., 1994) states that career interest and career choice are influenced by self-efficacy (the belief that you have the capability to successfully perform) and outcome expectations (beliefs of what you can get) in a domain. Women tend to have lower self-efficacy for STEM careers than men, which has been shown to explain gender differences in STEM interests (Lent & Brown, 2019; Tellhed et al., 2017). However, SCCT is not focused on explaining particularly gender differences. An influential theory that explicitly points to gender stereotypes for explaining gender differences in career choice is Eccles' expectancy-value theory (EEVT; Eccles, 1987; 1994), recently updated to the situated expectancy-value theory (SEVT; Eccles & Wigfield, 2020). EEVT and SEVT postulate that gender stereotypes influence performance expectations (related to ability beliefs) and values (e.g. fun) that we associate with certain careers, which in turn predict career choice. EEVT has also received ample empirical support (Eccles & Wang, 2016; Guo et al., 2015; Lauermann et al., 2017). Recently, Master and Meltzoff expanded EEVT into the stereotypes, motivation, and outcomes model (STEMO; Master & Meltzoff, 2020), which similarly emphasizes the role of gender stereotypes for career interest and choice. STEMO also draws upon recent developments in social identity research, which point to the role of social belongingness (expectations of "fitting in") for gender differences in career interest (see Master & Meltzoff, 2020 for a review). Like SCCT, STEMO also puts special emphasis on career interest as an outcome variable, since interest has been shown to be the main predictor of career choice (Maltese & Tai, 2011).

Further, the goal congruity perspective (GCP; Diekman et al., 2016) recently included career goal endorsement and career goal affordance (perceived goal fulfillment in careers) as predictors of gender differences in career interest. GCP states that the perceived affordance of agentic (e.g. earning a high salary) and communal goals (e.g. helping others) of different careers may attract or deter people's interest, depending on their career goal endorsement (their motivation to achieve these goals). STEM careers, including engineering, tend to be perceived as not fulfilling communal career goals well. This may deter women's interest, since women tend to endorse communal career goals to a higher degree than men (Diekman et al., 2016).

In this study, we draw on these theories for our selection of the main dependent variable (interest) and the proposed predictors. We will test if a gender difference in engineering interest is explained (statistically mediated) by gender differences in engineering self-efficacy, social belongingness in engineering and communal career goal endorsement. Our main aim is however to investigate if an industry-financed STEM intervention increases young women's engineering self-efficacy, their social belongingness in engineering and their perception that engineering can fulfill communal career goals. Drawing on the described theories, this could increase women's interest in engineering. We will next elaborate on the empirical support for each proposed factor in more detail.

Self-Efficacy and Stereotype Threat

Self-efficacy is defined as a person's belief that he or she has the capability to succeed in a domain (Bandura, 1977; 1997) and is a central factor in SCCT (Lent et al., 1994). It is closely related to ability beliefs as it is understood in EVVT and SEVT (Eccles, 1987; 1994; Eccles & Wigfield, 2020; Wigfield & Eccles, 2000). Self-efficacy has been shown to be an important predictor of career interest, even stronger than actual ability, measured as performance on ability tests (Bandura, 1997; Brown et al., 2008; Lent & Brown, 2019).

In the context of the present study, we focus on specifically engineering self-efficacy and measure the extent to which students believe that they have what it takes to succeed in an engineering program. Two large studies with randomly selected elementary school and high school students in Sweden recently showed that self-efficacy was the strongest mediator of gender differences in STEM interest and STEM choice (Tellhed et al., 2017; 2018). According to Bandura, there are four sources of self-efficacy: mastery experience (succeeding while performing in a domain), social persuasion (receiving encouragement), vicarious experience (having role models) and physiological arousal (e.g. experiencing low stress; Bandura, 1977; 1997). Some studies have found that mastery experience is the most important source of self-efficacy (Britner & Pajares, 2006), while others have found that girls' self-efficacy is more influenced by social persuasion and vicarious experiences from relevant role models in their lives, and boys' self-efficacy more by mastery experiences (Zeldin et al., 2008). This could relate to girls having less exposure to learning experiences in STEM areas than boys and therefore having less opportunity for mastery experiences (Master et al., 2017; Williams & Subich, 2006).

Bandura (1977; 1997) also states that physiological arousal may interfere with self-efficacy development. This is relevant for stereotype threat, which is defined as a situational threat where negative stereotypes about ability, such as women's STEM ability, can negatively affect the stereotyped groups (Steele 1997; Steele & Aronson, 1995). Examples of the negative effects are temporary performance impairment on tests and a reduced ability to judge one's own performance, which may explain why women develop lower self-efficacy for STEM (Aronson & Inzlicht 2004; Spencer et al., 2016; Tellhed & Adolfsson, 2018). In addition to engineering self-efficacy, we also test for gender differences in stereotype threat in relation to engineering in this study. We expand previous research by investigating if the industry-financed STEM intervention increases women's engineering self-efficacy and reduces their stereotype threat in relation to engineering.

Social Belongingness

As mentioned, there has recently been an increased focus on another predictor of STEM interest, namely social belongingness, which the STEMO model emphasizes (Master & Meltzoff, 2020). Social belongingness is defined as the perception of fitting in socially with others (Baumeister & Leary 1995; Walton & Cohen 2007). For the context of this study, we measure the extent to which students expect to fit in socially with their classmates if they choose to study an engineering program. Girls typically expect to have lower social belongingness in relation to STEM educations than boys (Tellhed et al., 2017). This may be due to the dominance of men in STEM and to perceptions of what a STEM person is like. Studies have found that women feel lower belongingness when they are numerically underrepresented (Schuster & Martiny, 2017) and when their ingroup is negatively stereotyped in the field (Cheryan et al., 2017). For example, previous research has shown that it is a common perception that STEM is for innately gifted white men (Cheryan & Plaut, 2010). Gender differences in social belongingness for STEM mediate gender differences in STEM interest (Good et al., 2012; Tellhed et al., 2017) and students who identify with STEM are more likely to choose a career in STEM (Hazari et al., 2010). A study by Wynn and Correll (2017) found that women's sense of matching the cultural image of successful tech workers was a stronger predictor of their intentions to persist in tech companies than their sense of matching the skill stereotype of people succeeding in tech careers. In this study, we test for gender differences in social belongingness in engineering programs and expand previous research by investigating if the intervention raises women's social belongingness.

Communal Career Goals

Next to engineering self-efficacy and social belongingness, the last factor we measure in this study in relation to engineering interest is communal career goals. As previously mentioned, GCP (Diekman et al., 2016) states that congruity is reached when goal endorsement, which indicates how important certain goals are to an individual, is met by goal affordance, that is to what extent the person believes that a certain career choice can fulfill these goals (Diekman et al., 2010; 2011; 2016). The theory differentiates between stereotypically masculine "agentic" goals, such as high status and a good salary, and stereotypically feminine "communal" goals, such as helping others and benefitting society. Previous research has shown that women tend to endorse communal career goals to a higher degree than men and perceive that these cannot be fulfilled well in engineering, which partially explains gender differences in STEM interest (e.g. Diekman et al., 2010; 2011; 2016). In a recent study in Sweden, a gender difference in communal career goals explained part of a gender difference in STEM choice but was a less important mediator compared to a gender difference in ability beliefs (Tellhed et al., 2018).

Research shows that explaining how communal career goals can be fulfilled in STEM careers may raise women's interest in STEM (Brown et al., 2015; Diekman et al., 2011), especially among women with limited experience of the field (Diekman et al., 2016). In this study, we test for gender differences in communal career goal endorsement in engineering. We also contribute to the field by investigating if the industry intervention raises perceptions of communal goal affordance in engineering. Several studies have investigated career goals in combination with either self-efficacy (e.g. Diekman et al., 2010) or social belongingness (Hazari et al., 2010), but it is uncommon to include all three factors, which we aim to do in this study.

The Focus of this Study

Many STEM employers have realized that they need to attract many more women to secure their future workforce. One such example is the public water sector in Sweden, which works closely with schools to offer teaching materials and study visits as well as longer interventions. The intervention we focus on in this study is the course *Think* H_2O. It is a two-day outdoors interdisciplinary course for high school students, which aims to increase teenagers' awareness of water and sustainability issues and increase their interest in a career in the water sector. It has been designed by the Swedish water sector and has been running for the past 9 years.

The aim of this study is to examine the interventions' effectiveness at raising specifically women's interest in studying engineering as well as examining the factors and mediators that can explain gender differences in interest. Empirically testing industry interventions is important, to learn about their effectiveness in changing beliefs about STEM, and how they may be improved by relying on psychological theory regarding what shapes career interest and gender differences in it.

We focus on the effect the intervention has on women, since women are underrepresented in engineering. However, we will also study the effect the intervention may have on young men's beliefs about engineering, since both men and women attend *Think* H_2O. Most of our participants will be enrolled in the natural science program in high school. Official statistics show that engineering is the most common choice of university program for men in the natural science high school program (54% make this choice, Skolverket, 2014). In contrast, only 28% of women in the natural science program later chose engineering for university (Skolverket, 2014). We therefore expect the young men in this study to have quite high interest in engineering already before the intervention. Results from previous studies of how STEM interventions affect boys' and men's STEM interest have been inconclusive. Some found positive effects of interventions and others did not (Cheryan et al., 2011; Walton et al., 2015).

To conclude, we formulate the following hypotheses:

1. Women will have a) lower interest, b) lower self-efficacy, and c) lower social belongingness, and d) higher stereotype threat than men in relation to engineering. e) Women will also rate higher on communal career goal endorsement than men.
2. Gender differences in a) self-efficacy, b) social belongingness and c) communal career goal endorsement will mediate gender differences in interest in engineering.
3. Post intervention, women will show a) higher self-efficacy, b) higher social belongingness, and c) higher communal career goal affordance, and d) lower stereotype threat in relation to engineering, and e) higher interest in engineering as compared to pre-intervention and to a comparison group.

METHOD

Participants and Procedure

Participants were 722 Swedish high school students aged 16-20 (M = 17.15, SD = .49). Of those, 316 identified as men, 403 as women. One participant identified as "other" and two did not disclose their gender. Since gender was the focus of the analyses, they were therefore excluded. In Sweden, students choose a program focus for high school and the majority had chosen natural science (71.1%) or social science programs (20.7%).

We recruited participants by contacting nine schools that had received scholarships for the course *Think* H_2O and invited them to take part in the study. Eight schools accepted with 29 classes in total. We then recruited a comparison group consisting of 18 classes in the same school years that did not attend the course *Think* H_2O. See Table 1 for a breakdown of participant demographics by experiment group.

Table 1
Participant Demographics by Experiment Group

Variable	Intervention group n = 470	Comparison group n = 249
Gender (women, n (%))	279 (59.4%)	124 (49.8%)
Age (M (SD))	17.1 (0.40)	17.3 (0.61)
Program		
Natural Science	351 (74.7%)	160 (64.2%)
Social Science	80 (17.0%)	69 (27.7%)
Economics	6 (1.3%)	20 (8.0%)
Aesthetics	32 (6.8%)	0 (0.0%)
Technical	1 (0.2%)	0 (0.0%)

Note. M = mean, SD = standard deviation

The study design was longitudinal quasi-experimental, comparing measurements at three different time points as well as comparing an intervention to a comparison group. The students in the intervention condition answered a survey in class two weeks before their visit to the course *Think* H_2O (T1). They filled out the second survey at the end of the two-day course on site (T2) and the follow-up survey in class, three months after the course (T3). Participants in the comparison condition answered all three surveys in class in similar time intervals. Completing the survey took approximately 7 minutes.

Ethical Considerations

The study follows Swedish law for research (SFS 2003:460). We collected informed consent from all participants and informed them that participation was voluntary and that they could withdraw at any time. Each participant created their own unique code, enabling analysis of within-participant intervention effects while protecting their anonymity. We informed participants that the study investigated interest in technology-focused university programs, but not that gender was part of the analysis, to avoid priming effects.

Materials

Intervention. The intervention was the two-day interdisciplinary course *Think* H_2O, which is organized yearly at a lake in the south of Sweden by a local water company (https://sydvatten.se/for-skolor/stipendiet-tank-h20/). The course teaches high school students about water and sustainability issues and local teachers can apply for a scholarship to attend it. During the course, students participate in ten workshops, labs and lectures that educate on the hydrological cycle, insects and plants in the water, political conflicts in connection with water, virtual water, careers in the water sector, and how tap water is produced. Among other things, students build models of water flow dynamics using different materials, examine water samples and insects under a microscope, and brainstorm solutions for conflicts of interest between industry and environmental concerns. Figure 1 shows images from the course. The participants spend all day outdoors, cook their own dinner over an open fire and sleep in dorms on the campground. The goal of the course is to increase knowledge, stimulate students' creativity and problem-solving ability and raise their interest in water issues as well as for career options in the water sector, including engineering.

Figure 1

Impressions from the Course 'Think H_2O'

a) Receiving instructions, b) Testing the quality of water samples, c) Identifying insects under a microscope, d) Learning about risks of water contamination.

Questionnaire. The questionnaire measured interest in studying engineering at university level, engineering self-efficacy, social belongingness in engineering, stereotype threat, communal and agentic career goal endorsement, and perceived goal affordance of engineering jobs. Participants were given the following instructions "Engineering programs and professions exist in many different varieties, for example electrical engineering, civil engineering, chemical engineering, biotechnology, mechanical engineering and environmental engineering. When you answer the following questions, think of the type of engineering program that you would be most interested in." Participants rated all items on Likert scales ranging from "not at all" (1) to "very much" (5).

We measured interest in engineering with three items adapted from Tellhed et al. (2017) and Lent et al. (2001). The items were developed within the SCCT paradigm (Lent & Brown, 2006) and have been used in a Swedish context previously (Tellhed et al., 2017). Questions included how interested students were in studying an engineering program at university. Cronbach's alpha was .928 at T1, .934 at T2 and .939 at T3. We measured engineering self-efficacy with three items, including how confident students were that they could pass such a program with the highest or second highest grade. Items were adapted from previous studies (Lent et al., 2001; Mamaril, 2014; Tellhed et al., 2017). The items had an internal reliability of α = .849 at T1, .873 at T2 and .893 at T3. We measured social belongingness in engineering with three items, including how well students expected to fit in socially with their classmates if they studied an engineering program. The items were adapted from Lent et al. (2001) and Walton and Cohen (2007) and had an internal reliability of α = .859 at T1, .871 at T2, and .908 at T3. To measure career goal endorsement, we used Diekman et al.'s well-established goal endorsement scale (Diekman et al., 2011; 2016), translated into Swedish by Tellhed et al. (2018). The scale consists of 15 items measuring agentic goal endorsement (e.g. high salary) and 10 items measuring communal endorsement (e.g. helping others). We measured goal endorsement only at T1, since we did not expect change in this measure. Internal reliability for agentic goals was α = .883 and for communal goals α = .849. In line with Diekman et al. (2011), we measured communal and agentic goal affordance with one item each, asking to what extent respondents believed that an engineering degree leads to jobs that could fulfill such goals. Lastly, we measured stereotype threat with three items adapted from Lent et al. (2001) and Tellhed et al. (2017) with an internal reliability of α = .845 at T1, .865 at T2, and .879 at T3. Items included how likely students expected teachers and classmates to have preconceptions or treat them unfairly because of their gender.

Outline of the Statistical Analysis

The data were analyzed using jamovi version 2.2.5 (The jamovi project, 2021) and R version 4.1.0 (R Core Team, 2021) including the PROCESS macro for R version 4.1 (Hayes, 2022). For Hypothesis 1, we analyzed baseline gender differences using independent sample *t*-tests in jamovi. For Hypothesis 2, we conducted a hierarchical multiple linear regression analysis in R to test for mediation and estimated indirect effects using bootstrapping in the PROCESS macro. For Hypothesis 3, we ran linear mixed model analyses in jamovi using the GAMLj module.

RESULTS

Preparatory Analyses

Only participants who identified as either men or women were included in the analysis. We included all participants who took part in all three measurements, even if they did not fill in all items on the survey. The final sample size was n = 719. Eleven participants were identified as multivariate outliers with a Mahalanobis distance significant at $p < .001$ (Tabachnick & Fidell, 1996). However, we retained them, since excluding them did not change the pattern of results. There was only one univariate outlier on communal career goal endorsement and we deleted their score on that variable. Assumptions of multivariate normality were fulfilled. Assumptions of homogeneity of variances were fulfilled for all variables except communal career goal endorsement and affordance and stereotype threat.

The comparison group was significantly different from the intervention group in terms of gender ($\chi^2(1) = 6.04$, $p = .014$) and program distribution ($\chi^2(4) = 49.49$, $p < .001$, see Table 1). Furthermore, the men in the intervention group had higher interest at baseline than the men in the comparison group ($t(314) = 2.93$, $p = .004$, see Table 2). There were no significant baseline differences (T1) for women between the groups. However, there were significant differences between programs, with students in the natural science program and technical program scoring significantly higher on engineering self-efficacy ($F(4, 2142) = 99.19$) social belongingness, ($F(4, 2137) = 117.00$), and interest in engineering ($F(4, 2142) = 193.40$, all $ps < .001$).

Gender Differences

Independent sample t-tests showed expected baseline (T1) gender differences in all relevant variables, supporting Hypothesis 1. Women had lower engineering self-efficacy ($t(717) = -7.16$), social belongingness ($t(715) = -8.79$), and interest in engineering ($t(717) = -7.89$) than men. Women also rated higher on stereotype threat ($t(713) = 12.14$) and communal career goal endorsement ($t(713) = 6.05$, all $ps < .001$) than men. See Table 2 for mean scores.

Table 2

Mean Scores (and Standard Deviations) for Each Group and Timepoint

Variable (*M*(*SD*))	Intervention Women *n* = 279	Intervention Men *n* = 191	Comparison Women *n* = 124	Comparison Men *n* = 125
Self-efficacy				
T1	2.41 (0.87)	3.00 (0.95)	2.47 (0.95)	2.82 (1.02)
T2	2.65 (0.96)	3.15 (0.90)	2.51 (0.97)	2.94 (1.06)
T3	2.56 (0.96)	3.21 (0.96)	2.62 (0.97)	2.95 (1.02)
Belongingness				
T1	2.62 (0.80)	3.15 (0.78)	2.58 (0.74)	3.07 (0.75)
T2	2.74 (0.86)	3.24 (0.81)	2.60 (0.78)	3.02 (0.81)
T3	2.65 (0.87)	3.32 (0.83)	2.69 (0.77)	3.10 (0.83)
Agentic goal endorsement (at T1)	3.19 (0.61)	3.40 (0.67)	3.29 (0.58)	3.43 (0.67)
Communal goal endorsement (at T1)	3.70 (0.64)	3.41 (0.68)	3.75 (0.55)	3.43 (0.74)

Communal goal affordance				
T1	2.95 (0.85)	3.02 (0.86)	2.98 (0.89)	3.11 (0.93)
T2	3.19 (0.98)	3.25 (0.86)	2.98 (0.90)	3.01 (0.95)
T3	2.97 (0.96)	3.20 (0.85)	3.10 (0.84)	3.11 (1.00)
Stereotype threat				
T1	2.02 (0.80)	1.36 (0.58)	1.97 (0.75)	1.36 (0.56)
T2	1.89 (0.81)	1.35 (0.65)	1.86 (0.69)	1.43 (0.65)
T3	1.94 (0.81)	1.32 (0.58)	1.85 (0.70)	1.36 (0.62)
Interest				
T1	2.24 (1.08)	3.09 (1.14)	2.31 (1.14)	2.69 (1.21)
T2	2.31 (1.10)	3.08 (1.14)	2.28 (1.13)	2.66 (1.22)
T3	2.19 (1.10)	3.02 (1.18)	2.27 (1.17)	2.61 (1.26)

Note. T1 = baseline, T2 = post intervention, T3 = three months follow-up, *M* = mean, *SD* = standard deviation

Mediation

Next, we tested whether self-efficacy, social belongingness and communal career goal endorsement mediate the gender differences in engineering interest (Hypothesis 2). We conducted a hierarchical multiple linear regression analysis to test for mediation. We included participants' high school program as a covariate due to significant baseline differences between the programs. For this analysis, we coded it as a binary factor, grouping natural science and the technical program as "STEM" and social science, economics and aesthetics as "non-STEM". We entered gender and high school program at the first step, which accounted for 30.2% of the variance ($F(2, 2107) = 454.7$, $p < .001$). Since previous research has found evidence supporting either self-efficacy or belongingness to be the stronger predictor of interest, we added both variables at the same time as step 2. This increased the variance explained by the model to 51.6% ($F(2, 2105) = 560.5$, $p < .001$). We added communal career goal endorsement as step 3. The whole model explained 51.9% of the variance in interest ($F(5, 2104) = 454.3$, $p < .001$). Even though the increase in R^2 was only marginal, the model improvement was statistically significant ($p < .001$).[1] All included variables were significant predictors of engineering interest (see Table 3) with belongingness being the strongest predictor ($\beta = .480$).

Table 3

Hierarchical Regression Analysis Predicting Engineering Interest

Predictor	*B*	SE (*b*)	*t*	*p*	β
Intercept	1.752	0.164	10.699	< .001	
Gender woman – man	-0.133	0.039	-3.400	< .001	-0.055
Program non-STEM – STEM*	-0.684	0.045	-15.275	< .001	-0.260
Belongingness	0.669	0.027	25.169	< .001	0.480
Self-efficacy	0.119	0.022	5.349	< .001	0.099
Communal goal endorsement	-0.106	0.028	-3.849	< .001	-0.060

* Program: STEM = natural science, technical; non-STEM = social science, economics, aesthetics

We estimated indirect effects using bootstrapping by the PROCESS macro. We tested parallel mediation with model 4 (Hayes, 2022). The total effect of the model was significant (*b* = -.515, CI [-.601, -.428], *p* < .001). There were significant indirect effects of social belongingness, self-efficacy and communal career goal endorsement (see Table 4). Contrasts showed that the indirect effect of belongingness was significantly stronger than that of self-efficacy (Contrast 1) or communal goal endorsement (Contrast 2), but those two did not differ significantly (Contrast 3). Since the direct effect of gender was still significant (*b* = -.133, CI [-.210, -.056], *p* < .001) this was a partial mediation. Hypothesis 2 was supported.

Table 4
Indirect Effects of the Mediators on Engineering Interest

	b	SE (*b*)	LLCI*	ULCI*
Total	-0.382	0.028	-0.437	-0.328**
Belongingness	-0.302	0.025	-0.352	-0.254**
Self-efficacy	-0.049	0.010	-0.071	-0.030**
Communal goal endorsement	-0.031	0.009	-0.049	-0.015**
Contrast 1	0.253	0.027	0.201	0.308**
Contrast 2	0.272	0.027	0.219	0.324**
Contrast 3	0.019	0.014	-0.008	0.046

*LLCI and ULCI indicate the lower limit and upper limit of the 95% confidence interval (CI). ** Significant as CI does not include zero.

Effects of the Intervention
To test Hypothesis 3, we ran linear mixed model analyses. We ran separate models for the dependent variables self-efficacy, social belongingness, stereotype threat, communal career goal affordance and interest. For each model, we included condition, time point and gender as fixed factors as well as interactions between all three. We included participant as random effect and program as a covariate. We used a Satterthwaite method to compute the degrees of freedom.

Self-Efficacy. To test Hypothesis 3a, that women have higher engineering self-efficacy after the intervention as compared to before, and as compared to the comparison group, we tested a model with self-efficacy as the dependent variable. There was a significant interaction effect of condition*time point*gender (*F*(2, 1421) = 3.48, *p* = .031). The model explained 13% of the variance. Post-hoc tests showed that women's self-efficacy increased significantly after the intervention (T2) (*t*(1421) = -6.47, *p* < .001, *d* = -.39) and remained significantly higher than baseline (T1) at the follow up measure (T3) (*t*(1420) = -4.08, *p* < .001, *d* = -.24). Their self-efficacy was significantly higher than that of the comparison group at T2 (*t*(988) = 2.0, *p* = .046, *d* = .15) but not at T3 (*p* = .977) due to an unexpected increase for the comparison group (see Table 2). For women in the comparison group, self-efficacy did not increase at T2 (*p* = .538) but did increase at T3 (*t*(1420) = -2.60, *p* = .009, *d* = -.23). Men's self-efficacy also increased from T1 to T2 (*t*(1422) = -3.27, *p* = .001, *d* = -.25) and to T3 (*t*(1420) = -4.77, *p* < .001, *d* = -.32). However, for men in the comparison group, self-efficacy also significantly increased from T1 to T2 (*t*(1420) = -1.97, *p* = .049, *d* = -.18) and to T3 (*t*(1420) = -2.17, *p* =

.030, *d* = -.17). Therefore, the two groups did not differ significantly from each other at T2 (*p* = .240) or T3 (*p* = .089). Results can be seen in Figure 2. Hypothesis 3a was supported.

Figure 2
Estimated Marginal Means for Engineering Self-Efficacy

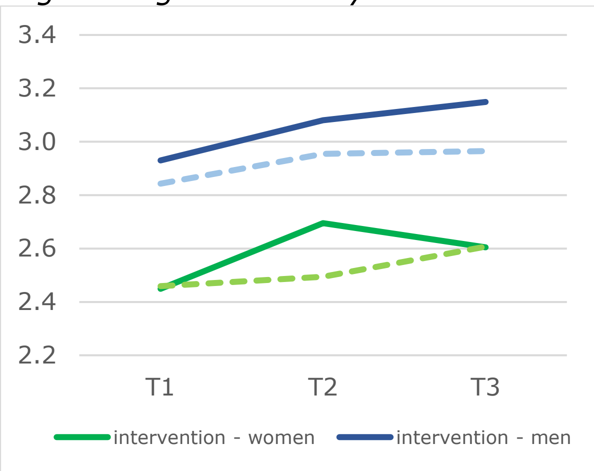
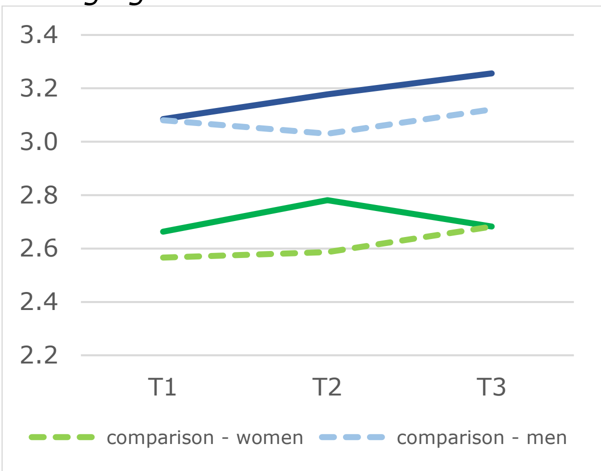


Figure 3
Estimated Marginal Means for Social Belongingness



Social Belongingness. To test Hypothesis 3b, that women have higher social belongingness in engineering after the intervention as compared to before, and as compared to the comparison group, we conducted a model with belongingness as the dependent variable. There was a significant interaction of condition*time point*gender ($F(2, 1417) = 3.23$, $p = .04$). The model explained 17.9% of the variance. Women in the intervention group scored significantly higher at T2 ($t(1417) = -3.26$, $p = .001$, $d = -.19$) but their belongingness decreased back to baseline scores at T3 ($p = .580$). Consequently, they had higher belongingness than the comparison group at T2 ($t(1085) = 2.31$, $p = .021$, $d = .17$) but not at T3 ($p = .991$). Furthermore, women in the comparison group did not show higher belongingness at T2 ($p = .714$), but their belongingness increased at T3 ($t(1415) = -2.15$, $p = .031$, $d = -.23$). Men's belongingness increased significantly at T2 ($t(1418) = -2.09$, $p = .037$, $d = -.15$) and even further at T3 ($t(1416) = -3.94$, $p < .001$, $d = -.30$). However, their belongingness was not significantly higher than that of the comparison group at T2 ($p = .104$) and T3 ($p = .132$). Men in the comparison group did not show higher belongingness at T2 ($p = .342$) or T3 ($p = .461$). See Figure 3 for results. Overall, these results support Hypothesis 3b, although the effects do not last at T3.

Communal Career Goal Affordance. To test Hypothesis 3c, that women have higher beliefs that engineering careers can fulfill communal goals after the intervention as compared to before, and as compared to the comparison group, we tested a model with communal goal affordance as the dependent variable. There was a significant interaction of condition*time point ($F(2, 1413) = 8.40$, $p < .001$), but the model only explained 2.2% of the variance. In the intervention group, women's perceived communal goal affordance increased significantly at T2 ($t(1412) = -4.28$, $p < .001$, $d = -.25$) but was reduced again at T3 ($p = .718$). It was significantly higher than that of the comparison group at T2 ($t(1533) = 2.43$, $p = .015$, $d = .23$) but not at T3 ($p = .274$). Women in the comparison group did not show a change in communal goal affordance at T2 (*p*

= .920) or T3 (p = .187). Men's scores increased at T2 (t(1417) = -3.18, p = .002, d = -.22) and remained significantly higher than baseline at T3 (t(1413) = -0.17, p = .013, d = -.17). However, their scores were not significantly different from the comparison group at T2 (p = .051) or T3 (p = .639). Men in the comparison group did not show a change in communal goal affordance at T2 (p = .282) or T3 (p = .860). See Figure 4 for results. Overall, these results support Hypothesis 3c, although the effects do not last at T3.

Stereotype Threat. To test Hypothesis 3d, that women would have lower stereotype threat after the intervention as compared to before, and as compared to the comparison group, we tested a model with stereotype threat as the dependent variable[2]. The model explained 14.3% of the variance. There was a significant interaction of gender*time point (F(2, 1407) = 3.84, p = .022), but no three-way interaction with condition (p = .628). This indicates a significant decrease for women after the intervention, but the same pattern was true for the comparison group. In the intervention group, women's stereotype threat significantly decreased at T2 (t(1406) = 3.03, p = .003, d = .18) but slightly increased again at T3 to marginally significantly different from baseline (T1) (t(1405) = 1.92, p = .055, d = .11). In the comparison group, women's stereotype threat was marginally reduced at T2 (p = .054) and significantly reduced at T3 (t(1402) = 2.17, p = .030, d = .18). The groups did not differ significantly at T2 (p = .692) or T3 (p = .267). Men's scores did not change over time in the intervention group (p = .768 at T2, p = .329 at T3) or in the comparison group (p = .240 at T2, p = .928 at T3), or differ between groups at any point (p = .382 at T2, p = .698 at T3) (see Figure 5). This was expected, since men should not be affected by stereotype threat in engineering due to their gender. Hypothesis 3d was partly supported.

Figure 4

Estimated Marginal Means for Communal Career Goal Affordance

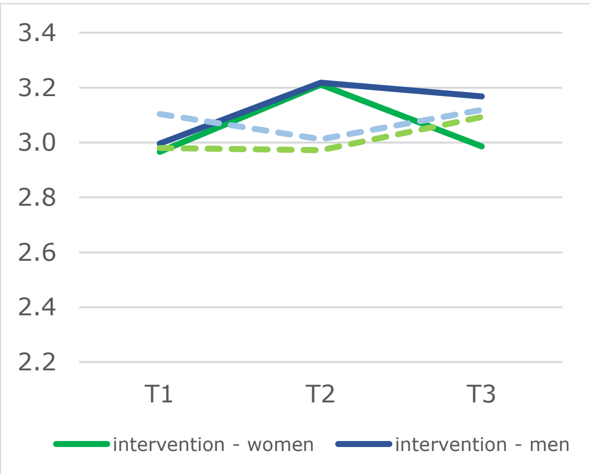
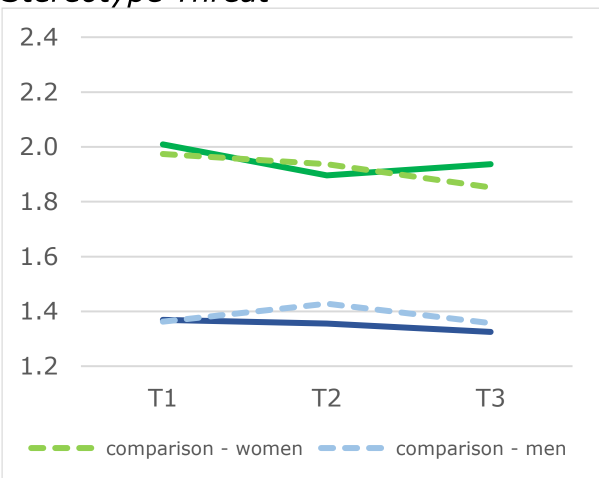


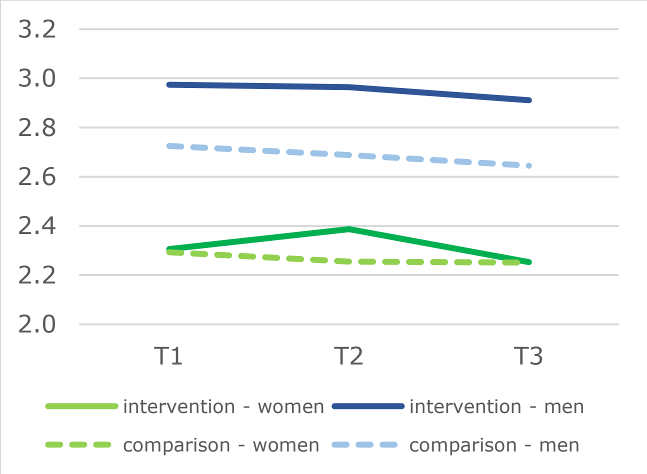
Figure 5

Estimated Marginal Means for Stereotype Threat



Interest. Lastly, we tested Hypothesis 3e, that women would have higher engineering interest after the intervention, as compared to before, and as compared to the comparison group, with a model with interest as the dependent variable. The model explained 20% of the variance. There were significant main effects for condition, time point and gender, but the interaction between condition and time point was not significant (p = .251) (see Figure 6), so the intervention did not have a significant effect on participants' interest. Hypothesis 3e was therefore not supported.

Figure 6
Estimated Marginal Means for Engineering Interest



DISCUSSION

Engineering is still dominated by men and this study evaluated if an industry-financed intervention could raise young women's interest in engineering, through increases in self-efficacy, social belongingness, and perceived communal career goal affordance. We also evaluated if the intervention could lower women's stereotype threat for engineering, since that may keep also highly interested women from choosing this career path.

Mediation of Gender Differences in Engineering Interest

As predicted, the results showed that men were more interested in engineering than women and that gender differences in social belongingness, self-efficacy and communal career goals could explain (statistically mediate) this difference. Social belongingness was the strongest mediator in this study, which is in line with findings from the US (Cheryan & Plaut, 2010) and supports the recent STEMO model (Master & Meltzoff, 2020), that emphasizes the importance of social belongingness for explaining gender differences in STEM interest. However, this result contrasts a previous study in Sweden, where self-efficacy was a stronger mediator than belongingness of a gender difference in a broader sense of STEM interest, in a representative sample of similar-aged participants (Tellhed et al., 2017). This difference may relate to the fact that the majority of participants in the present sample have already chosen a STEM program for high school (natural science) or that the present study measured particularly engineering, while the previous study had a broader STEM approach. Further, women had higher communal career goals than men in this study, and these contributed to mediate the gender differences in engineering interest. This finding corroborates previous studies and supports the goal congruity perspective (e.g. Diekman et al., 2010; 2011; 2016; Tellhed et al., 2018). In this study, self-efficacy and communal career goals were similarly strong mediators of interest, contrary to previous findings from Sweden, where ability beliefs were the more important factor (Tellhed et al., 2018). However, the participants in the present study were older than in the previous study, which may explain why career goal considerations were more impactful in the present study. Our study thus implies that the women's lower interest in engineering, as compared to the men's, was explained by the fact that the women were less certain that they would fit in socially in an engineering program, that they had the necessary skills to succeed in it, and that engineering careers would fulfill their communal career goals.

The Intervention's Effect on Women

The results supported the hypotheses that the *Think* H_2O intervention would raise women's engineering self-efficacy, social belongingness, and perceived communal career goal affordance in engineering and reduce associated stereotype threat. Although the effect sizes were small, these are promising results, and they suggest that industry-designed interventions can have beneficial effects on women's beliefs about engineering. Reviews of previous interventions have shown varied effects, with interventions sometimes even worsening women's STEM perceptions (e.g. Betz & Sekaquaptewa, 2012). This industry-designed intervention focused on water and sustainability issues and not specifically on engineering. This implies that adapting the intervention to a more tailored focus on engineering could possibly strengthen it to improve beliefs about engineering even further, which we discuss in more detail below.

We tested the effect of the intervention as a whole and could therefore not disentangle what components of the intervention particularly raised engineering self-efficacy and social belongingness in women, which were both mediators of gender differences in interest. A speculation is that the increases were related to the students having STEM-related mastery experiences from the intervention's practical activities and from meeting several female STEM role models (leaders and teachers) in the two-day intervention. Social cognitive theory (Bandura, 1977; 1997) points to the importance of mastery experiences as well as role models (vicarious experience) for self-efficacy development. Further, both STEMO (Master & Meltzoff, 2020) and the stereotype inoculation model (Dasgupta, 2011) emphasize the significance of role models for belongingness.

As is the case in most intervention research, most of the effects were reduced at the follow-up measure three months later. However, women's self-efficacy remained increased, as compared to the pre-measure, at the follow-up measure. This was the strongest effect of the intervention. This is promising, since self-efficacy has been identified as a key factor keeping women out of STEM (Eccles & Wang, 2016; Hackett, 1995; Lent & Brown, 2019; Master & Meltzoff, 2020; Rottinghaus et al., 2003; Tellhed et al., 2017, 2018; Watt, 2010).

There were some unexpected changes in the comparison group. Women in the comparison group showed no changes at the second time point (T2) but had higher self-efficacy and social belongingness as well as lower stereotype threat at the three months follow up measure (T3). This unexpected result could speculatively suggest that repeatedly answering questions about engineering could influence answers. Alternatively, since the classes in the comparison group had applied to attend *Think* H_2O but did not receive a scholarship, it is possible that teachers did other STEM activities in class as a substitute for taking part in the intervention.

Despite the intervention raising women's engineering self-efficacy, social belongingness, and perceptions that engineering can afford communal career goals, it did not raise women's interest in engineering. This was unexpected, since these factors are described as predictors of career interest and career choice in SCCT (Lent et al., 1994), EEVT (Eccles, 1987; 1994), SEVT (Eccles & Wigfield, 2020), STEMO (Master & Meltzoff, 2020) and the goal congruity perspective (Diekman et al., 2016). Social belongingness was very strongly related to women's engineering interest in this study and self-efficacy and communal career goal affordance were also moderately related to interest. This perhaps suggests that stronger increases in these factors might be necessary to raise women's engineering interest. Also, as previously mentioned, to increase engineering interest, one may have to design the intervention to concern engineering more explicitly than was the case in this intervention, which had a more interdisciplinary STEM focus on water issues. Furthermore, girls' interest in engineering has been shown to decrease with age (Sadler et al., 2012) and a large study by the Microsoft Corporation suggests that it drops significantly between 15 and 16 years of age (Microsoft Corporation, 2017). Interventions aiming to raise interest could therefore be more effective if they target younger girls.

The Intervention's Effect on Men

Although the focus of this study was on investigating the impact of the intervention on women, we also explored its effect on men. The results showed that like for women, the intervention raised self-efficacy, social belongingness and communal career goal affordance in engineering for men. Further, contrary to the effects for women, who only showed long-term increases in self-efficacy, men's increases as compared to baseline remained significant at the three months follow-up measure for all three factors. Therefore, it appears that the intervention had a more durable impact on men than on women. However, the men's results should be interpreted with caution, since the men in the comparison group also showed increases in these factors over time, for unknown reasons.

It is possible that STEM interventions may benefit men's long-term beliefs about engineering more than women's, since men are generally more interested in engineering than women and may therefore be more susceptible to STEM-related information. Alternatively, women's beliefs about engineering may be less durable after an intervention than men's, since women may encounter messages that "Engineering is for men" after the intervention. Future research may want to explore these possibilities through interviewing students at a follow-up measure after an intervention.

Limitations and Future Research

This study's design was unusually strong for intervention research, by including both pre- and follow-up measures and by including a comparison (control) group, which did not attend the intervention. However, there were limitations in the design due to the applied nature of the study.

First, we could not randomize participants to the intervention versus the comparison group since we were limited to recruiting participants from school classes where the teacher had applied to the intervention. We tried to match the participants in the comparison group to the intervention group by recruiting classes in the same high schools which had either not applied to the intervention or had applied but had not received the scholarship. Because of this limitation, the comparison group was smaller than the intervention group, had a higher proportion of women, and the specific high school program distribution (STEM vs non-STEM programs) varied between the intervention and the comparison group. As mentioned, this limitation makes especially interpretations of the men's results difficult. The men in the intervention group had higher interest in engineering than the comparison group at the baseline measure, which impedes interpretations of the intervention effects. Perhaps the men in the intervention group had higher engineering interest initially because more participants in the intervention group had already chosen to study science in high school. We encourage future studies to find methods to better randomize intervention participants, although this generally is a challenge for evaluations of industry-designed interventions.

Second, a problem with all intervention studies is demand effects, where participants provide responses that comply with the perceived hypothesis. There were some significant changes in the comparison group from T1 to T3. This could also be a demand effect of repeatedly answering surveys about engineering. We therefore encourage replications with a placebo control group or adding implicit measures, which are more resistant to such effects.

Third, investigating the effects of existing industry-designed interventions aimed at school students is important, especially since some interventions have negative effect on students' STEM perceptions (e.g. Betz & Sekaquaptewa, 2012). However, investigating an already existing intervention means that researchers have no influence over the intervention components. We encourage future collaborations between the industry and researchers to find out how interventions can be strengthened to maximize their effect, based on psychological theory. As Unrau et al. (2018) point out, tapping into multiple sources of self-efficacy when designing interventions, such as including mastery experience, social persuasion and using role models, increases their impact. Since women tend to underestimate their abilities (Cadaret et al., 2017), feedback and encouragement about their engineering potential could also further increase their self-efficacy. To make intervention effects last longer, future studies may also want to provide a boost or reminder after some period of time. Furthermore, we encourage future studies to include a qualitative component to provide a more comprehensive picture of how interventions affect students.

Suggestions for the Industry

This study shows that scientifically evaluating STEM interventions is important, especially for interventions created by the industry that run for several years, reach large numbers of students, and may possibly have a real impact on their life. Unfortunately, this is rarely done or done poorly, for example without including a pre-intervention baseline measure or a control group (Valla & Williams, 2012). Several previous studies have shown how difficult it is to design effective interventions, because they can also backfire. For example, studies using role models may sometimes have negative effects on women's self-efficacy and interest (Betz & Sekaquaptewa, 2012; Rudman & Phelan, 2010).

A cooperation between industry and research could therefore help these types of industry interventions, for example by collaborating with psychologists to improve the interventions and make them more tailored and effective at fulfilling the goal of raising interest in STEM careers, such as engineering. If the aim is to increase women's self-efficacy, social belongingness and interest in engineering, we suggest including elements based on Bandura's (1977; 1997) theory of sources of self-efficacy as well as the more recent STEMO model (Master & Meltzoff, 2020) which discusses determinants of belongingness. Drawing on these models, the intervention should allow students to get successful performance experience in the domain, meet several non-stereotypical and relatable role models and be encouraged for their efforts. In addition, measures should be taken to reduce women's stereotype threat by for example describing gender similarity in cognitive abilities related to engineering (Hyde et al., 2019) rather than affirming gender stereotypes (Liu et al., 2021; Sparks, 2016; Spencer et al., 2016; Spitzer & Aronson, 2015). To achieve longer lasting effects of interventions like this one, collaboration with schools could be increased. Teachers applying for the course could be encouraged to follow up the intervention in school, to boost or maintain its effects over time. Further, staying in touch with previous participants, for example via social media or newsletters, to remind participants of their experiences at the intervention, may be helpful.

Our study was conducted on one specific intervention run by the Swedish water sector. However, the results concern basic psychological processes behind which factors can raise self-efficacy and social belongingness, which according to theory should in turn increase interest. In line with Bandura's theory (1977; 1997), it is possible that the intervention increased self-efficacy because the students had mastery experiences during the intervention's activities and met role models from the sector, which may have also contributed to raising their social belongingness. These processes should be generalizable to other contexts and STEM fields.

Summary and Conclusion

This study showed that an industry-designed STEM intervention raised women's engineering self-efficacy, social belongingness and perceived communal career goal affordance for engineering careers, although most of the effects were only short term. Future research should investigate ways to strengthen the effects and make them last longer. The findings are promising for companies designing similar types of interventions as well as policy makers invested in improving the gender balance in engineering.

ENDNOTES

[1] Since communal goal endorsement did not fulfill the assumption of homogeneity, we also conducted a robust regression analysis. The results showed the same pattern as the least squares regression in Table 3.

[2] The assumption of homogeneity of variances was violated for stereotype threat. This was due to men's low variance in scores, which was expected, since men typically do not experience stereotype threat based on gender. However, we still conducted the analysis since gender differences were not the focus of this specific analysis.

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REFERENCES

Aronson, J., & Inzlicht, M. (2004). The ups and downs of attributional ambiguity: Stereotype vulnerability and the academic self-knowledge of African American college students. *Psychological Science*, *15*(12), 829–836. https://doi.org/10.1111/j.0956-7976.2004.00763.x

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Freeman

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497–529. https://doi.org/10.1037/0033-2909.117.3.497

Bench, S.W., Lench, H.C., Miner, K., Flores, S.A., & Liew, J. (2015). Gender gaps in overestimation of math performance. *Sex Roles*, 72, 536 –546. https://doi.org/10.1007/s11199-015-0486-9

Betz, D. E., & Sekaquaptewa, D. (2012). My fair physicist? Feminine math and science role models demotivate young girls. *Social Psychological and Personality Science, 3*, 738–746. https://doi.org/10.1177/1948550612440735

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, *43*(5), 485-499. https://doi.org/10.1002/tea.20131

Brown, E. R., Thoman, D. B., Smith, J. L., & Diekman, A. B. (2015). Closing the communal gap: The importance of communal affordances in science career motivation. *Journal of Applied Social Psychology*, *45*(12), 662-673. https://doi.org/10.1111/jasp.12327

Brown, S. D., Tramayne, S., Hoxha, D., Telander, K., Fan, X., & Lent, R. W. (2008). Social cognitive predictors of college students' academic performance and persistence: A meta-analytic path analysis. *Journal of Vocational Behavior*, *72*(3), 298–308. https://doi.org/10.1016/j.jvb.2007.09.003

Cadaret, M. C., Hartung, P. J., Subich, L. M., & Weigold, I. K. (2017). Stereotype threat as a barrier to women entering engineering careers. *Journal of Vocational Behavior*, *99*, 40–51. https://doi.org/10.1016/j.jvb.2016.12.002

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: sociocultural and biological considerations. *Psychological Bulletin*, *135*(2), 218-261. https://doi.org/10.1037/a0014412

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science, 2*(6), 656–664. https://doi.org/10.1177/1948550611405218

Cheryan, S., & Plaut, V. C. (2010). Explaining underrepresentation: A theory of precluded interest. *Sex Roles*, *63*(7-8), 475-488. https://doi.org/10.1007/s11199-010-9835-x

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143*(1), 1–35. https://doi.org/10.1037/bul0000052

Dasgupta, N. (2011): Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry, 22*(4), 231-246. https://doi.org/10.1080/1047840X.2011.607313

Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological Science, 21*(8), 1051-1057. https://doi.org/10.1177/0956797610377342

Diekman, A. B., Clark, E. K., Johnston, A. M., Brown, E. R., & Steinberg, M. (2011). Malleability in communal goals and beliefs influences attraction to STEM careers: Evidence for a goal congruity perspective. *Journal of Personality and Social Psychology*, *101*(5), 902–918. https://doi.org/10.1037/a0025199

Diekman, A. B., Steinberg, M., Brown, E. R., Belanger, A. L., & Clark, E. K. (2016). A goal congruity model of role entry, engagement, and exit: Understanding communal goal processes in STEM gender gaps. *Personality and Social Psychology Review*, 21(2), 142–175. http://doi.org/10.1177/1088868316642141

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly*, *11*(2), 135–172. https://doi.org/10.1111/j.1471-6402.1987.tb00781.x

Eccles, J. S. (1994). Understanding women's educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly, 18*(4), 585–609. https://doi.org/10.1111/j.1471-6402.1994.tb01049.x

Eccles, J. (2011). Gendered educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *International Journal of Behavioral Development*, *35*(3), 195–201. https://doi.org/10.1177/0165025411398185

Eccles, J. S., & Wang, M.-T. (2016). What motivates females and males to pursue careers in mathematics and science? *International Journal of Behavioral Development*, *40*(2), 100–106. http://doi.org/10.1177/0165025415616201

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology, 61*, 1–13, https://doi.org/10.1016/j.cedpsych.2020.101859

EIGE (2017). *Economic benefits of gender equality in the EU: How gender equality in STEM education leads to economic growth*. European Institute for Gender Equality (EIGE).

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology, 102*(4), 700–717. https://doi.org/10.1037/a0026659

Guo, J., Parker, P. D., Marsh, H. W., & Morin, A. J. S. (2015). Achievement, motivation, and educational choices: A longitudinal study of expectancy and

value using a multiplicative perspective. *Developmental Psychology, 51*(8), 1163–1176. https://doi.org/10.1037/a0039440
Hackett, G. (1995). Self-efficacy in career choice and development. In A. Bandura (Ed.). *Self-efficacy in changing societies* (pp. 232–258). Cambridge University Press. https://doi.org/10.1017/CBO9780511527692.010
Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis, third edition: a regression-based approach*. The Guilford Press.
Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching, 47*(8), 978-1003.
Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. *American Psychologist*, *74*(2), 171–193. https://doi.org/10.1037/amp0000307
Lauermann, F., Tsai, Y.-M., & Eccles, J. S. (2017). Math-related career aspirations and choices within Eccles et al.'s expectancy–value theory of achievement-related behaviors. *Developmental Psychology, 53*(8), 1540–1559. https://doi.org/10.1037/dev0000367
Lent, R. W., & Brown, S. D. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of Career Assessment*, *14*(1), 12–35. https://doi.org/10.1177/1069072705281364
Lent, R. W. & Brown, S. D. (2019). Social cognitive career theory at 25: Empirical status of the interest, choice, and performance models. *Journal of Vocational Behavior*, *115*, 1-14. https://doi.org/10.1016/j.jvb.2019.06.004
Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, *45*(1), 79–122. https://doi.org/10.1006/jvbe.1994.1027
Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology*, *48*(4), 474–483. https://doi.org/10.1037/0022-0167.48.4.474
Liu, S., Liu, P., Wang, M., & Zhang, B. (2021). Effectiveness of stereotype threat interventions: A meta-analytic review. *Journal of Applied Psychology*, *106*(6), 921-949. https://doi.org/10.1037/apl0000770
Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95,* 877-907. https://doi.org/10.1002/sce.20441
Mamaril, N. J. A. (2014). Measuring undergraduate students' engineering self-efficacy: A scale validation study. *Theses and Dissertations - Educational, School, and Counseling Psychology*. 19. http://uknowledge.uky.edu/edp_etds/19
Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. *Journal of Experimental Child Psychology, 160,* 92-106. https://doi.org/10.1016/j.jecp.2017.03.013

Master, A., & Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. *International Journal of Gender, Science & Technology*, *12*(1), 152–198. http://genderandset.open.ac.uk/index.php/genderandset/article/view/674/1124

Microsoft Corporation (2017). *Why Europe's girls aren't studying STEM*. Microsoft Philanthropies, retrieved April 13, 2022, from https://news.microsoft.com/wp-content/uploads/2017/02/Microsoft_girls_in_STEM_final-Whitepaper.pdf

Miller, D. I., Eagly, A. H., & Linn, M. C. (2015). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology, 107,* 631-644. https://doi.org/10.1037/edu0000005

Nordic Council of Ministers (2021: 518). *Genusperspektiv på framtidens högteknologiska arbetsliv: En nordisk forskningsöversikt om utbildningsval inom STEM (Science, Technology, Engineering and Mathematics).* [A gender perspective on the high-tech work life of the future: A Nordic literature review of educational choice of STEM.] https://www.norden.org/sv/publication/genusperspektiv-pa-framtidens-hogteknologiska-arbetsliv

R Core Team. (2021). *R: A language and environment for statistical computing [computer software]*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/

Rottinghaus, P. J., Larson, L. M., & Borgen, F. H. (2003). The relation of self-efficacy and interests: A meta-analysis of 60 samples. *Journal of Vocational Behavior*, *62*, 221–236. https://doi.org/10.1016/S0001-8791(02)00039-8

Rudman, L. A., & Phelan, J. E. (2010). The effect of priming gender roles on women's implicit gender beliefs and career aspirations. *Social Psychology, 41,* 192–202. https://doi.org/10.1027/1864-9335/a000027

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education, 96*, 411–427. https://doi.org/10.1002/sce.21007

Saini, A. (2017). *Inferior: How science got women wrong - and the new research that's rewriting the story.* Beacon Press.

Schuster, C., & Martiny, S. E. (2017). Not feeling good in STEM: Effects of stereotype activation and anticipated affect on women's career aspirations. *Sex Roles*, *76*(1), 40–55. https://doi.org/10.1007/s11199-016-0665-3

SFS 2003:460. Lag om etikprövning av forskning som avser människor. [Act concerning the Ethical Review of Research Involving Humans]. https://rkrattsbaser.gov.se/sfst?bet=2003:460

Shin, J. E. L., Levy, S. R., & London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology*. https://doi.org/10.1111/jasp.12371

Shoffner, M. F., & Dockery, D. J. (2015). Promoting interest in and entry into science, technology, engineering, and mathematics careers. In *APA handbook of career intervention, Volume 2: Applications.* (pp. 125–137). American Psychological Association

Skolverket, (2014). Vad ungdomar gör efter Naturvetenskapsprogrammet. Retrieved May 12, 2017, from https://www.skolverket.se/polopoly_fs/1.256421!/Programblad_NV_gy2000.pdf

Sparks, D. (2016). Reducing stereotype threat in the science and mathematics classroom: An overview of research, best practices, and intervention strategies. *Currents in Teaching & Learning, 7*(2), 4–17.

Spencer, S. J., Logel, C., & Davies, P. G. (2016). Stereotype threat. *Annual Review of Psychology*, *67*, 415–437. http://doi.org/10.1146/annurev-psych-073115-103235

Spitzer, B., & Aronson, J. (2015). Minding and mending the gap: Social psychological interventions to reduce educational disparities. *British Journal of Educational Psychology*, *85*(1), 1-18. https://doi.org/10.1111/bjep.12067

Statistics Sweden (2020). Employees 16-64 years at national level by occupation (4-digit SSYK 2012), sector and sex. Year 2019 – 2020. Retrieved April 13, 2022, from https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__AM__AM0208__AM0208E/YREG50N/

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, *52*(6), 613–629. http://doi.org/10.1037/0003-066X.52.6.613

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*(5), 797–811. http://doi.org/10.1037/0022-3514.69.5.797

Swedish Public Employment Service (2022, May 19). *Heta yrken 2026.* [Press release]. https://arbetsformedlingen.se/om-oss/press/pressmeddelanden?id=D9C0FC6A36143C62

Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics (3rd edn).* Harper Collins College.

Tellhed, U., & Adolfsson, C. (2018). Competence and confusion: How stereotype threat can make you a bad judge of your competence. *European Journal of Social Psychology, 48*(2), 189-197. https://doi.org/10.1002/ejsp.2307

Tellhed, U., Bäckström, M., & Björklund, F. (2017). Will I fit in and do well? The importance of social belongingness and self-efficacy for explaining gender differences in interest in STEM and HEED majors. *Sex Roles*, *77*(1–2), 86–96. https://doi.org/10.1007/s11199-016-0694-y

Tellhed, U., Bäckström, M., Björklund, F. (2018). The role of ability beliefs and agentic vs. communal career goals in adolescents first educational choice. What explains the degree of gender-balance? *Journal of Vocational Behavior, 104*, 1–13. https://doi.org/gcjjh7

Tellhed, U., Björklund, F., & Kallio-Strand, K. (under review, 2022). Tech-savvy men and caring women: Middle school students’ gender stereotypes relate to their interest in tech-educations.

The jamovi project (2021). *jamovi*. (Version 2.2) [Computer Software]. Retrieved from https://www.jamovi.org

United States Census Bureau (2021) https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html

Unrau, N. J., Rueda, R., Son, E., Polanin, R. J., Lundeen, R. J., & Muraszewski, A. K. (2018). Can reading self-efficacy be modified? A meta-analysis of the impact of interventions on reading self-efficacy. *Review of Educational Research*, *88*(2), 167–204, https://doi.org/10.3102/0034654317743199

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), *2014 and 2018 Technology and Engineering Literacy (TEL) Assessments*. https://www.nationsreportcard.gov/tel_2018_highlights/

Valla, J. M., & Williams, W. M. (2012). Increasing achievement and higher-education representation of under-represented groups in science, technology, engineering, and mathematics fields: A review of current K-12 intervention programs. *Journal of Women and Minorities in Science and Engineering*, *18*, 21–53. https://doi.org/10.1615/JWomenMinorScienEng.2012002908

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology*, *92*(1), 82–96. https://doi.org/10.1037/0022-3514.92.1.82

Walton, G. M., Logel, C., Peach, J. M., Spencer, S. J., & Zanna, M. P. (2015). Two brief interventions to mitigate a “chilly climate” transform women’s experience, relationships, and achievement in engineering. *Journal of Educational Psychology, 107*(2), 468–485. https://doi.org/10.1037/a0037461

Watt, H. M. G. (2010). Gender and occupational choice. In J. C. Chrisler & D. R. McCreary (Eds.), *Handbook of gender research in psychology* (pp. 379–400). Springer.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

Williams, C. M., & Subich, L. M. (2006). The gendered nature of career related learning experiences: A social cognitive career theory perspective. *Journal of Vocational Behavior, 69*(2), 262–275. https://doi.org/10.1016/j.jvb.2006.02.007

Wynn, A. T. & Correll, S. J. (2017). Gendered perceptions of cultural and skill alignment in technology companies. *Social Sciences*, *6*(2), 1-28. https://doi.org/10.3390/socsci6020045

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers*. Journal of Research in Science Teaching, 45*(9), 1036–1058. https://doi.org/10.1002/tea.20195