Supporting Information

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SI Materials and Methods

Participants. The families who participated in this randomized controlled trial (32) have also participated in a larger, longitudinal study since 1990–1991 (Wisconsin Study of Families and Work; for recruitment details, see ref. 47). Median household income at the time of recruitment was $50,000; in 1991, the median income of married couple families in the United States with the wife in the paid labor force was $48,169 (48). Therefore, our sample matches the national figure well. Average years of parents' education was 15.42 y (SD = 1.92) on a scale where 12 y was equivalent to high-school graduation or GED completion. The racial breakdown of the students reflected the state in which the sample was recruited: 90% were White (not of Hispanic origin), 2% were African American, 1% were Native American, and 7% were biracial or multiracial (46).

The original sample for the current study had 188 families in 108 different high schools, but seven students and their parents were dropped from analyses because we did not receive a high-school transcript for them. This lack of transcript occurred for a variety of reasons, including a lack of consent and homeschooling (32). Collection of the transcript did not vary by condition or gender.

Intervention Materials. The intervention consisted of sending intervention group parents two brochures in the mail and also giving them access to a password-protected website. The first set of intervention materials consisted of a single brochure entitled, "Making Connections: Helping Your Teen Find Value in School," sent to both parents when the students were in 10th grade. Because prior research had shown that many parents did not know why common topics in mathematics and science could be useful or relevant (30), this brochure contained information and examples about the usefulness of STEM topics in their child's life (e.g., calculating sales prices when shopping, mathematics courses in high school as necessary for a variety of college majors). It also encouraged parents to discuss these topics with their child and provided them with strategies and advice about how to communicate this information most effectively with their child. The advice centered on involving children in generating personally relevant examples.

A second set of intervention materials was sent in 11th grade to both parents individually and included a second brochure entitled, "Making Connections: Helping Your Teen with the Choices Ahead," as well as access to a password-protected website entitled "Choices Ahead." This brochure gave additional examples of how STEM topics were relevant in everyday life and also included a greater focus on how STEM topics were important for a variety of careers and majors in college. There were also additional tips and encouragement given to parents about the ways in which they could communicate this information effectively to their child. More specifically, there were three overarching sections in this brochure: (*i*) information on specific occupations in mathematics, physics, biology, and chemistry, as well as how individuals in these fields used mathematics and science in their everyday activities; (*ii*) separate sections on the relevance of STEM topics for everyday activities, adult life more generally, and college and career planning in particular; and (*iii*) information on ways to overcome challenges in communicating this information to the child (e.g., parents were asked to first find connections with mathematics and science in their own lives and then help their child discover examples specific to their lives).

The website contained extensive information related to the relevance of mathematics and science for college and career planning. It also offered parents the opportunity to send specific links from the website to their students via email. The information on the website was broken up into four sections. The precollege planning section included specific pages for both the parent and student, and each page provided links and information on websites where students could find more career and college planning information (e.g., a link to a website that focused on finding the right college, a link to a website that allowed one to search a database of potential careers). The next section included information on the preparation needed to obtain a career in biology, chemistry, physics, and mathematics, with more clickable links specific to those fields. The third section provided parents and students with career information on four career domains in particular: biology and chemistry, healthcare (medicine, nursing, and veterinary), physics and engineering, and mathematics and architecture. Finally, the last section included more information on mathematics and science in one's everyday life as well as testimonials from students at University of Wisconsin–Madison detailing how their mathematics and science preparation in high school has been important for their college trajectories (e.g., "Although I did not particularly care for math or science in high school, once I got to college, I was so glad that I opted to take advanced level courses in each. I didn't realize at the time how much a strong background in math and science would help me with the required courses for my major, like zoology and statistics. Math and science classes weren't the most interesting to me, but they very well may have been the most useful, and I probably would have struggled through many college courses had I decided only to take the minimum level of math and science required for graduation.").

Measures. Student's' transcripts were collected after graduation, as previously reported (32), and we also collected students' WKCE and ACT scores from school records for the current study. Another set of measures was collected through a survey given during the summer 2 y after students' senior years of high school. The proportion of missing data for the variables described below did not significantly differ by experimental condition.

11th and 12th grade STEM courses-taking. High-school transcripts were collected (control: male $n = 53$, female $n = 47$; intervention: male $n = 42$, female $n = 39$) and coded for number of semester of mathematics and science taken in 11th and 12th grade (mean = 7.85; SD = 2.57; response rate: 100%).

Mathematics and science ACT score. ACT scores were collected through official high-school records from the students, and the mathematics and science ACT scores were averaged to create a composite mathematics and science ACT score measure (mean = 24.55; SD = 4.39; response rate: 71%).

College STEM course-taking. Mathematics and science college course-taking was assessed by asking students 2 y after their senior year of high school how many science and mathematics courses they had taken so far in college. A composite measure of college STEM course-taking was created by summing the two variables (mean = 5.86; SD = 3.87; response rate: 68%).

STEM career aspirations. Two years after students' senior year of high school, students responded to an open-ended question asking what career they envisioned themselves having at age 30. Responses to this open-ended question were matched to careers using the O*NET OnLine career coding system, which is sponsored by the US Department of Labor, Employment, and Training. The O*NET OnLine website (www.onetcenter.org/overview.html) offers scores, referred to as knowledge values, for mathematics (mean = 55.25; SD = 18.37), physics (mean = 23.00; SD = 21.52), chemistry (mean = 25.33; SD = 22.16), biology (mean = 31.97; SD = 29.93), and engineering and technology (mean = 27.72; SD = 24.23) on a scale from 0 to 100 for each career. A higher score on a knowledge value indicates that a higher level of knowledge in that topic is needed for that career. For example, a career as a civil engineer would have higher scores on the five knowledge values compared with a career as a lawyer. Once careers were matched to a career on the O*NET online website, the highest of five knowledge values was used for each student to create the STEM career aspirations measure (mean = 61.70; SD = 20.90; response rate: 65%).

College STEM major. Two years after students' senior year of high school, students were also asked to report their major using an open-ended question. The majors were coded as a STEM major or a non-STEM major using two independent observers, and disagreements were resolved by an independent third coder (40.17% STEM majors; response rate: 65%).

Perceived STEM value. Students' STEM value (M = 5.50; SD = 1.50) was assessed 2 y after students' senior year of high school with three items measured on a 1 (strongly disagree) to 7 (strongly agree) scale that asked about the students' perceptions of the importance of mathematics and science in general, as well as in their future career and classes ("Math and science are important for my future"; "I will use math and science in my job or career"; "I want to take more math and science classes in the future." α = 0.91; response rate: 73%).

Perceived parental STEM support. Perceived parental STEM support (mean = 5.93; SD = 1.01) 2 y after students' senior year of high school was assessed using three items measured on a 1 (strongly disagree) and 7 (strongly agree) scale that asked about how much students' parents valued and encouraged mathematics and science topics and courses ("My parents think math and science are important for my life"; "My parents encouraged me to take math and science courses"; "My parents have encouraged me to do well in my math and science courses." α =0.84; response rate: 73%). This variable was used to assess if students in our intervention group viewed their parents as being more supportive of their STEM career pursuit than students in the control condition. Because this was not a primary student variable of interest, we only reported analyses on this variable in *SI Results*.

Parents' education level. Both parents reported on the number of years of education they received. Twelve years was equivalent to a high-school graduate, 16 y was equivalent to a 4-y college graduate, and greater than 16 y indicates some amount of graduate school. Mothers (mean = 15.42; SD = 2.10) and fathers (mean = 15.42; SD = 2.41) reported generally similar levels of education on average. A variable of parents' average years of education was created by averaging the two variables (mean = 15.42; SD = 1.92; response rate: 100%).

Preintervention standardized test scores. We collected Wisconsin 10th grade state mathematics and science standardized test scores (WKCE scores) from students' high-school records to have a preintervention measure of students' performance. The test was given in the fall of 10th grade, before the intervention. Students who attended private schools or out-of-state schools did not take Wisconsin state tests. A composite of students' WKCE mathematics and science test scores (mean = 533.74; SD = 36.10; response rate: 60%) was created by averaging across their mathematics and science subscale scores. As reported in the main text, there was not a significant difference between intervention and control group students on WKCE mathematics and science test scores.

SI Results

Variance Explained in Main Structural Equation Model. The main model of interest in the paper (all predictors included and allowed to predict all subsequent variables in the model) accounted for 9.1% of the variance for 11th and 12th grade mathematics and science course-taking, 25.0% of mathematics and science ACT score, 9.0% of students' college STEM value, 31.9% of college STEM course-taking, 13.5% of STEM career aspirations, and 11.3% of college STEM major choice.

Regression Analyses on ACT Scores. We conducted two additional regressions to address concerns about randomization. In the first regression, we tested whether the intervention affected mathematics and science ACT score, as we do in the main model in the paper, which involved regressing mathematics and science ACT score on the seven base predictors (intervention, students' gender, parents' education level, and the interactions between those variables). In the next regression, we ran the same model on the same dependent variable, but we included students' preintervention mathematics and science test score measure in the analysis, which controlled for preintervention competence. When controlling for prior performance, there was a significant effect of the intervention on mathematics and science ACT score (z = 3.61, β = 0.20, P < 0.001), consistent with the analysis without controlling for prior performance (z = 2.45, β = 0.19, P < 0.05). Full results from these two regressions are reported in Table S3. From these analyses, the intervention has a consistent and significant positive effect on students' mathematics and science ACT scores.

Supplemental Structural Equation Model, Including Perceived Parental STEM Support. For this analysis, we estimated an identical model to the model described in the main text, except that we also included perceived parental STEM support as a posthigh-school outcome along with perceived STEM value, college STEM course-taking, STEM career aspirations, and college STEM major. The purpose of this analysis was to examine whether the intervention had a long-term effect on students' perceptions of the amount of encouragement and support they had from their parents to pursue STEM careers, even years after the intervention. Brief, theory-based interventions are hypothesized to work via recursive processes, whereby a change in attitude helps to change behavior, which in turn supports the initial change in attitude (34). Here, we are able to test for part of this recursive process by examining the long-term effect of the intervention on students' perceptions of how supportive and encouraging their parents are about STEM. Given the important roles that parents' perceived attitudes have in students' motivation (27, 33), it is useful to know if this parent-delivered intervention affected students' long-term perceptions of their parents' attitudes in addition to their own STEM attitudes and behaviors. Overall, although this was not a primary dependent variable of interest, it does speak to how a parent-centered intervention might have lasting effects on how students feel supported by their parents in STEM domains long after the initial interactions that were encouraged by the intervention.

As with the primary model, this model is saturated, so there are not interpretable indices of model fit. All significant effects from the model reported in the main text remained significant in this supplemental model. New tests showed that mathematics and science ACT score was a significant predictor of perceived parental STEM support (z = 3.47, β = 0.38, P < 0.001), such that students with higher mathematics and science ACT scores reported greater levels of perceived parental STEM support. Additionally, there was a significant indirect effect of the intervention on perceived parental STEM support through high-school STEM course-taking and ACT scores (z = 2.13, P < 0.05). In all, the model explained 16.4% of the variance in perceived parental STEM support. Thus, this finding supports the recursive process theory of psychological interventions by demonstrating that the intervention affected perceptions of parental STEM support 5 y after the intervention through effects on high-school STEM course-taking and ACT scores.

Table S1. Zero-order correlations and descriptive statistics for major study variables

Variable	1	2	3	4	5	6	7	8
1. Parental education	—							
2. 11th and 12th grade mathematics and science course-taking (semesters)	0.22**	—						
3. Mathematics and science ACT score	0.38***	0.30**	—					
4. Perceived STEM value	0.00	0.23**	0.20*	—				
5. College STEM course-taking (semesters)	0.29*	0.43***	0.39**	0.49***	—			
6. STEM career aspirations	0.06	0.34***	0.20	0.60***	0.47***	—		
7. College STEM major	0.11	0.30**	0.15	0.55***	0.48***	0.56***	—	
8. Perceived parental STEM support	0.13	0.12	0.31**	0.53***	0.28**	0.34***	0.30***	—
Mean	15.42	7.85	24.55	5.50	5.86	61.70	—	5.93
SD	1.92	2.57	4.39	1.50	3.87	20.90	—	1.01

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. UV, utility value. Mean and SD are not reported for students' college STEM major (40% STEM major and 60% non-STEM major) because it is a dichotomous measure with 1 indicating STEM major and 0 indicating not a STEM major.

Table S2. Summary of significant parameter estimates for direct and indirect effects for the model

Parameter	*z*	β
Direct effects		
11th & 12th grade mathematics and science course-taking		
Intervention	2.22*	0.16
Parental education	3.13**	0.23
Mathematics and science ACT score		
Intervention	2.46*	0.19
Parental education	4.92***	0.42
Perceived STEM value (after high school)		
11th and 12th grade mathematics and science course-taking	2.29*	0.22
College STEM course-taking		
11th and 12th grade mathematics and science course-taking	3.77***	0.34
Mathematics and science ACT score	2.36*	0.26
STEM career aspirations (after high school)		
11th and 12th grade mathematics and science course-taking	3.13**	0.30
College STEM major		
11th and 12th grade mathematics and science course-taking	2.82**	0.29
Indirect effects		
Intervention → College STEM course-taking	2.54*	—
Intervention → Student's' STEM value	2.15*	—
Intervention → STEM career aspirations	2.19*	—

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Table S3. Unstandardized βs and SEs for regressions on ACT scores

Predictor	Math and science ACT	Math and science ACT
Intervention	0.88* (0.36)	0.92*** (0.25)
Parental education	1.70*** (0.40)	0.53 (0.30)
Gender	0.13 (0.36)	−0.17 (0.26)
Intervention × Gender	0.27 (0.36)	0.05 (0.26)
Intervention × Parental education	−0.40 (0.40)	−0.01 (0.29)
Parental education × Gender	0.35 (0.40)	−0.04 (0.29)
Intervention × Parental education × Gender	−0.58 (0.40)	0.02 (0.29)
Preintervention test scores		0.10*** (0.01)

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Each column is a single multiple regression. Column headers are the outcomes for each multiple regression, and the left hand column includes the predictors for each regression. Unstandardized coefficients and SEs are reported for each predictor (SEs are reported in parentheses). Preintervention standardized test scores are only included in the second analysis. Gender is coded as +1 for male and −1 for female.

Table S4. Unstandardized betas and SEs for direct effects on posthigh-school outcomes in a structural equation model without high-school STEM preparation variables

Predictor	College STEM course-taking	Student's' STEM value	College STEM major	STEM career aspirations
Intervention	0.02 (0.35)	−0.02 (0.13)	0.00 (0.05)	1.70 (1.90)
Parental education	1.12** (0.36)	0.00 (0.14)	0.05 (0.05)	1.11 (1.99)
Gender	−0.11 (0.35)	0.10 (0.13)	0.00 (0.05)	0.14 (1.90)
Intervention × Gender	−0.16 (0.35)	−0.04 (0.13)	0.02 (0.05)	0.06 (1.90)
Intervention × Parental education	0.23 (0.36)	−0.01 (0.14)	0.00 (0.05)	0.80 (1.99)
Parental education × Gender	0.59 (0.36)	0.13 (0.14)	0.00 (0.05)	0.27 (1.99)
Intervention × Parental education × Gender	0.16 (0.36)	0.06 (0.14)	−0.04 (0.05)	−0.59 (1.99)

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Each column is the unstandardized direct effects on each posthigh-school outcome in a model without high-school STEM preparation variables (i.e., mathematics and science ACT score and high school STEM course-taking). Column headers are the posthigh-school outcomes, and the left hand column lists the predictors in our model. SEs are reported in parentheses. Gender is coded as +1 for male and −1 for female.