

REVIEW PROTOCOL FOR PROGRAMS TO FOSTER SUCCESS AMONG WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM)

Highlights

- The topic area for this review protocol is interventions designed to foster success among girls and women in science, technology, engineering, and mathematics (STEM).
- Reviews of causal studies in this topic area determined the quality of existing causal evidence on programs to encourage interest among girls and young women in pursuing education and careers in STEM fields and to foster success among women in STEM fields (referred to collectively as *Women in STEM*). CLEAR reviewed all identified causal studies.
- In addition, CLEAR reviewed a subset of descriptive studies in this topic area to shed light on the extensive body of noncausal research. This included studies that describe underrepresentation of women in STEM fields and conference proceedings describing the implementation of programs for girls and women.

Introduction

The topic area for this review protocol is programs designed to foster success among girls and women in STEM fields. Over the past decade, job growth in STEM occupations outpaced growth in other fields by nearly a three-to-one margin, and STEM jobs are expected to continue to grow nearly twice as fast as other jobs in the next decade.¹ STEM workers earn 26 percent more than workers in other occupations, even after adjusting for individual characteristics correlated with wages (for example, age, marital status, race, ethnicity, region, and industry). This STEM wage premium has steadily increased in recent years, from 18 percent in 1994 to 26 percent in 2010. Yet despite the strong demand for STEM workers and the fact that women fill almost half of all jobs in the economy, women are significantly underrepresented in STEM jobs, accounting for fewer than one-quarter of workers in STEM fields.²

There are many explanations for women's underrepresentation in STEM majors and careers. Male high school students continue to outscore their female counterparts by small margins on high-stakes exams, such as the Scholastic Assessment Test (SAT), American College Test (ACT), and Advanced Placement exams in STEM subjects, even though female high school students earn math and science credits at the same rate as males and have grade point averages in these courses slightly higher than males do.³ Although women are more likely than men to attend college, first-year female college students are about half as likely as their male counterparts to major in STEM fields (15 versus 29 percent, respectively). By graduation, about one-tenth of bachelor's degrees awarded to women are

¹ Langdon, D., McKittrick, G., Beede, D., Khan, B., & Domms, M. (2011). *STEM: Good jobs now and for the future*. Washington, DC: U.S. Department of Commerce, Economics & Statistics Administration.

² Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Domms, M. (2011). *Women in STEM: A gender gap to innovation*. Washington, DC: U.S. Department of Commerce, Economics & Statistics Administration.

³ Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few?: Women in science, technology, engineering, and mathematics*. Washington, DC: American Association of University Women.

in STEM fields, compared with one-quarter of bachelor's degrees awarded to men.⁴ Career paths continue to diverge after graduation, as women with baccalaureates in STEM are much less likely than their male counterparts to work in STEM jobs (26 versus 40 percent).⁵ To combat this so-called leaky pipeline, programs have been developed to encourage girls to persist in STEM studies and women to pursue and advance in STEM careers.

The Clearinghouse for Labor Evaluation and Research (CLEAR) review of this topic area had two aspects:

1. CLEAR determined the strength of evidence presented in Women in STEM studies with causal designs—that is, those seeking to determine the effectiveness of particular programs. Each causal study reviewed by CLEAR receives a causal evidence rating that summarizes the extent to which the study's design supports drawing conclusions about the effectiveness of the program or policy examined. This causal evidence rating is presented as one aspect of a study summary published on the CLEAR website. CLEAR reviewed all identified causal studies in this topic area.
2. CLEAR reviewed select studies of Women in STEM with noncausal designs, such as descriptive and implementation studies. Such studies do not attempt to determine the effectiveness of a particular policy or program, but instead describe underrepresentation of women in STEM, use statistical methods to determine factors that predict underrepresentation of women in STEM, describe programs aimed at increasing girls' interest and persistence in STEM education, or describe the implementation of programs to increase women's persistence in STEM careers. CLEAR reviewed a subset of descriptive studies in this topic area to shed light on the extensive body of noncausal research. Highlights of these studies are published on the CLEAR website.

Reviews of causal studies in this topic area focus on the following domains and outcomes of interest:

- **Interest in STEM:** Self-reported interest in pursuing a STEM course of study, major, or career
- **Attitudes toward STEM:** Self-reported attitudes towards pursuing a STEM course of study, major, or career
- **STEM enrollment:** Enrollment in STEM classes, workshops, summer programs, majors, or certificate or degree programs
- **Persistence in STEM:** Completion of STEM classes, workshops, summer programs, certificates, or degrees; includes K–12 and postsecondary education
- **Achievement in STEM:** Performance in STEM classes, majors, or programs as measured by grades, grade point averages, or test scores; includes K–12 and postsecondary education

⁴ Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Domms, M. (2011). Women in STEM: A gender gap to innovation. Washington, DC: U.S. Department of Commerce, Economics & Statistics Administration.

⁵ Hill, C., Corbett, C., & St. Rose, A. (2010). Why so few?: Women in science, technology, engineering, and mathematics. Washington, DC: American Association of University Women.

- **Employment in STEM:** Internships and employment in STEM jobs; wages, hours worked, earnings, benefits, and reported job satisfaction in STEM jobs; competitive awards, patents, and publications in STEM fields; or hiring, promotion, and retention in STEM careers

Eligibility Criteria

CLEAR conducted a broad literature search (see Appendix A for details) to identify all the research papers and reports on the topic of girls and women in STEM, and examined a list of suggested references provided by the U.S. Department of Labor's Women's Bureau. The literature and reference list searches uncovered causal studies examining the effectiveness of programs for girls and women in STEM; descriptive studies (examining, for example, trends in female participation in STEM over time or case studies of a woman or a group); and implementation studies describing a particular STEM program.

The CLEAR team screened the identified studies against two criteria for inclusion in the topic area review:

1. **Does the subject matter focus on girls or women in STEM?** Research that pertained to increasing participation in STEM fields more broadly was not included in the review. Research that focused on parents or teachers of girls or young women in STEM was also not included.
2. **Was it conducted in a relevant time and place?** To be most relevant to practitioners, policymakers, and other stakeholders, the research must have taken place since 1994 in the United States, including the 50 states, the District of Columbia, territories, and tribal entities.

The complete list of identified studies meeting these criteria is included in Appendix B. CLEAR conducted first-level reviews of a subset of the research meeting these eligibility criteria (see CLEAR Policies and Procedures for a discussion of the two levels of review). CLEAR further screened research using quantitative methods to determine whether it was eligible for a second-level review. This further eligibility screening focused on the following questions:

1. **Does it contain an impact analysis?** To meet this criterion, the research must have used quantitative methods to assess the effectiveness of a program, policy, or intervention. This includes research using quantitative methods that claimed to identify a causal impact and/or drew policy implications from its findings, even if the study's design did not support such claims.
2. **Does it examine an outcome of interest?** The research must have measurable impacts on one or more of the types of outcomes mentioned earlier.

All identified research meeting these additional criteria was reviewed according to CLEAR Causal Evidence Guidelines, Version 2.0. The full set of guidelines is available at <http://clear.dol.gov>.

Causal Evidence Guidelines Specific to the Topic Area

Attrition in randomized controlled trials (RCTs). The causal research in this topic area includes studies with both experimental and nonexperimental designs. CLEAR assesses the quality of evidence for RCTs using an adaptation of the Institute of Education Science's What Works

Clearinghouse standards.⁶ RCTs can receive a high causal evidence rating if there are no obvious confounds to the RCT design and if the level of attrition in the RCT is low. This topic area uses a conservative attrition standard, on the presumption that attrition in studies of programs for women in STEM might be linked with their educational or labor market outcomes. For instance, women who drop out of STEM careers could be difficult to track or unresponsive to data collection efforts and more likely to have poorer labor market outcomes than those that do not drop out; this means that high rates of missing data could yield a biased comparison of treatment and control groups. If CLEAR determines that an RCT cannot be rated as providing high causal evidence, the research is reviewed using the nonexperimental causal evidence guidelines developed by CLEAR.

Control variables for nonexperimental designs. CLEAR causal evidence guidelines for nonexperimental studies were developed in consultation with a technical working group of methodological experts. The guidelines cover most nonexperimental designs, including fixed effects, difference-in-differences, instrumental variables, and regressions. Nonexperimental designs and RCTs with high attrition can receive a moderate causal evidence rating if they include adequate controls and can demonstrate or adjust for anticipating the intervention and confounding factors. To meet the requirements for a moderate causal evidence rating, nonexperimental studies and RCTs with high attrition in this topic area must control for the following:

- Age
- Race and ethnicity
- At least one preprogram measure of academic achievement or employment, depending on the type of intervention examined. Preprogram measures of academic achievement would be appropriate for studies of programs designed to help young women in college persist in STEM majors and could include previous grade point average or standardized test scores. Preprogram measures of employment would be appropriate for studies of programs designed to help women employed in STEM fields to persist in those fields and could include measures of employment history or attachment to the labor market.

Regression methods that incorporate a matching design, which uses statistical methods to create a comparison group that is as similar as possible to the group receiving the program, must match on the previously listed control variables, or must include them as controls in the regression. Designs that do not meet the guidelines for nonexperimental studies receive a low causal evidence rating.

This topic area can also include analyses conducted at the group level (an aggregation of individuals, such as institutions, employers, or communities). For group analyses, it will typically be necessary to include controls at the group level for the same variables as in the individual analyses. However, the topic area principal investigator (PI) has the discretion to waive and/or add required control variables as the analysis warrants, in consultation with the topic area content expert and CLEAR's PI. For example, an analysis conducted at the high school level could include controls for average age and gender composition. However, the PI might recommend waiving these requirements because age and gender composition probably vary little across high schools. Depending on the intervention, the PI might instead recommend requiring additional controls such as total enrollment, urban or rural status, and racial and ethnic composition of the high schools.

⁶ See <http://ics.ed.gov/ncee/wvc/InsidetheWVC.aspx> for details.

Changes in group composition. Causal research designs in this topic area commonly use institution-level data, and CLEAR does not require that authors demonstrate that the composition of the groups being compared remain the same. Any changes in the composition or characteristics of workers in the aggregate due to a policy or program designed to promote the advancement of women in STEM fields can be seen as an impact of that policy or program, and thus should be part of the measured treatment effect. For example, if female junior faculty take positions with institutions that offer supports for women in STEM fields, increases in the percentage of STEM faculty who are women can be thought of as part of the impact of offering the program. Therefore, studies need not demonstrate that interventions left group composition unchanged.

Pre-intervention data for interrupted time series (ITS) designs. ITS designs are often used in the literature of interest to this topic area; a specific set of causal evidence guidelines covers such designs. ITS designs can receive a high, moderate, or low causal evidence rating depending on how many of the specified criteria the study meets. In general, to satisfy Criterion ITS.2, an ITS design must use data drawn from a sufficiently long period before an intervention's implementation. For the Women in STEM topic area, data must cover at least one year before the implementation of the intervention.

APPENDIX A LITERATURE SEARCH

The Clearinghouse for Labor Evaluation and Research (CLEAR) conducted comprehensive literature searches to identify research meeting the eligibility criteria described in the review protocol, with a particular focus on identifying research with causal designs. This included keyword searches of Scopus, which covers 19,500 peer-reviewed journals, 400 trade publications, 360 book series, and articles in press from more than 3,850 journals; as well as Academic Search Premier, Business Source Complete, EconLit, Education Research Complete, and the Education Resource Information Center (ERIC).⁷ CLEAR also created a custom Google search engine to examine information posted by 40 select organizations conducting research in these areas.

The following search parameters applied to both searches:

- Limited geographically to the United States
- Limited to the English language
- Limited to articles published from 1994 to the present
- Excluded editorials, letters, newspaper articles, and commentary
- Limited to causal studies; content analysis; descriptive studies; focus groups; field studies; implementation studies; interventions; narratives; and qualitative, quantitative, and thematic analyses
- CLEAR used combinations of the following search terms:
- Women OR Female* OR Girl*
- STEM OR “Science, Technology, Engineering, and Math*”
- Intervention* OR evaluation* OR demonstration* OR pilot* OR strategy* OR practice* OR model* OR curricula* OR program* OR policy OR policies
- Career* OR education OR Internship* OR Employment OR Wage* OR Hours OR Earnings OR Benefits OR “Job Satisfaction” OR Award* OR Patent* OR Publication* OR Advancement
- Efficacy OR Effect* OR Impact* OR Regression OR “Quasi-experimental” OR Nonexperimental OR “Fixed effect*” OR Experimental OR Benefit* OR Improve* OR Progress OR Causal OR Statistical* OR Random*

In addition, relevant research was identified by searching the websites of 40 organizations conducting research in these areas through a custom Google search tool:

- Abt Associates
- American Association of University Women
- American Enterprise Institute

⁷ For information about Scopus, see <http://www.info.sciverse.com/scopus/scopus-in-detail/facts>.

- American Institutes for Research
- Association for Public Policy and Management
- Booz Allen Hamilton
- Brookings Institution
- Catalyst
- Cato Institute
- Center for Economic Policy and Research
- Center for Law and Social Policy
- Center for Public Policy and Administration
- Congressional Research Library
- Decision Information Resources
- Economic Policy Institute
- Ethics and Public Policy Center
- Heritage Foundation
- IMPAQ
- Institute for Educational Leadership at Johns Hopkins
- Institute of Women's Policy Research
- IZA Institute for the Study of Labor
- Joint Center for Political and Economic Studies
- Levy Economics Institute
- Massachusetts Budget and Policy Center
- Mathematica Policy Research
- MDRC
- National Bureau of Economic Research
- NORC
- Pacific Research Institutes
- Public Policy Associates
- RAND Corporation
- Resources for the Future
- RTI International
- Social Policy Research Associates

- SRI International
- Tax Foundation
- The Center for Public Justice
- Urban Institute
- U.S. Bureau of Labor Statistics
- U.S. Government Accountability Office

Finally, CLEAR screened citations provided by the U.S. Department of Labor's Women's Bureau for eligibility.

APPENDIX B REFERENCES

Causal studies

Studies with a high causal evidence rating

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