Interventions to reduce the gender gap in STEM
Educator guide

PAPER DETAILS

Original title: Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation

Authors: Akira Miyake, Lauren E. Kost-Smith, Noah D. Finkelstein, Steven J. Pollock, Geoffrey L. Cohen, Tiffany A. Ito

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Annotator(s): Kaitlin Wilcoxen

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1. What are the advantages and disadvantages of studying the gender gap and values affirmation in a laboratory setting? In an authentic classroom setting?

2. Consider the implications of the men in the values affirmation condition performing worse on exams than the men in the control condition. How could you explain this result? How would you test these explanations?

3. What are some other situations where stereotypes might negatively affect performance of a certain group? How could you test whether these situations produce a gap, and whether values affirmation could reduce that gap?

4. All the measures used in this study relied heavily on performance on multiple-choice tests. What are the advantages and disadvantages of this approach? Can results from a study based on multiple-choice exams generalize to other types of tests?
### ACTIVITIES FOR INTERACTIVE ENGAGEMENT

#### Writing an abstract

Students write a new abstract for the article at a grade-appropriate reading level.

#### Locating this study in the larger field

Students should identify at least one paper (either from the references used by Miyake et al. or identify another on their own) related to stereotype threat or the gender gap. They should note how this research builds on the public work of at least one other independent group of scientists and reflect on the statement that scientific knowledge is a “community effort.” Students may write a short essay comparing the findings from this paper and the paper of their choosing. The essay should emphasize any similarities or differences in results and a comparison between the methods.

#### Science in the news

Students explore news stories in the Related Resources tab and evaluate the stories for tone, accuracy, missing information, etc. They may then write their own news stories on the article.

#### Alternative data

Students imagine that values affirmation did not close the gender gap. They should draw figures representing this result and explain the major differences between the new figures and the figures from the paper (particularly Figures 1 and 2).

#### Results and conclusions

Students diagram each of the experiments presented in the study (divided up by figure, if appropriate). They then consider the results depicted in each figure, and how these results support the conclusions of the study.

#### The next steps

Students design a follow-on experiment to this study that either addresses flaws or unanswered questions in the research at hand or builds on it to explore a new question.
ARTICLE OVERVIEW

Article summary (recommended for educator-use only)

Men tend to perform better than women on science, technology, engineering, and math (STEM) tests. This can affect women’s confidence in the disciplines and future job prospects. The authors in this study tested whether the values affirmation intervention, in which students spend 15 minutes writing about a value they find important, could be used to decrease the gap in exam performance between women and men in an introductory college physics class. They found that values affirmation closed the gender gap in exam performance both in the class and on a nationally-normed test, and especially helped women move from overall class grades of Cs to Bs. The effects lasted the duration of the course, even though the interventions took place early in the semester. Thus, values affirmation may be a promising way to help women perform to their full potential.

Importance of this research

Previous work has shown that people underperform when they’re worried about being an example of a negative stereotype. For example, according to some stereotypes, women are worse at math than men. In laboratory experiments, women may perform worse on math tests than men. This effect can be exaggerated by reminding women of the stereotype or eliminated by stating that there are no performance differences on the test between people of different genders. Previous work in the laboratory and with minority students in middle school classrooms has shown that the values affirmation intervention can improve performance for the negatively stereotyped group. Even a one-time intervention can have meaningful long-term positive effects. The researchers performed their study to determine whether a values affirmation intervention could be effective beyond a lab in a real-life college classroom setting.

Future students might assess the long-term effects of values affirmation, since the effects of a brief intervention seem to last months afterward, and whether the intervention needs to be repeated with a certain frequency to prevent reemergence of gaps. Similarly, further research could assess the effectiveness of earlier interventions (for example, starting in elementary school) compared to later interventions (like the college example in this paper), since the effects seem to snowball. Finally, further research could illuminate how values affirmation interacts with other pedagogical techniques.

Experimental methods

- Random assignment, double-blind study: The students didn’t know the true purpose of the exercise and the course instructors didn’t know which group the students were assigned to. Comparisons were made between groups pre- and post-intervention.
- Statistical analyses: These include T tests, F tests, Chi square tests, regressions, and normalization.
- Values affirmation intervention: Students received a packet (or online document) listing many possible values and were asked to circle two or three they found very important. Then, they described why those values were important to them. Finally, they were asked to list the top reasons why those values were important to them and rate how much they tried to live up to those values.
- Control intervention: Students received the same information as the students in the values affirmation condition. However, they were asked to think about values that might be important to others and why others might value those things (instead of thinking about their own personal values).
Conclusions

- Women performed worse than men in the control condition, confirming that there was a gender gap.
- The values affirmation intervention eliminated the gender gap in average exam scores and on an end-of-the-year national physics exam, indicating that values affirmation may help women improve their performance in physics classes. Additionally, these exams happened several weeks after the intervention, suggesting that values affirmation may have long-lasting effects.
The following tables provide an overview of the learning standards covered by this article, including the A Framework for K-12 Science Education (Framework), Common Core State Standards English Language Arts-Literacy (CCSS ELA), Common Core State Standards Statistics and Probability (CCSS HSS), AP Science Practices, and Vision and Change for Undergraduate Education. Where applicable, activities and information will be marked with specific standards to which they are linked.

### A Framework for K-12 Science Education

<table>
<thead>
<tr>
<th>Planning and carrying out investigations (SEP3)</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tr>
<td>Scientific investigation may be conducted in the field or the laboratory. Observation and data collected from such work are used to test existing theories and explanations or to revise and develop new ones.</td>
<td><strong>ETS1.B: Developing Possible Solutions</strong>&lt;br&gt;Complicated problems may need to be broken down into simpler components to develop and test solutions. When evaluating solutions, it is important to take into account a range of constraints, including cost, safely, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should lead to improvements in the design through an iterative process.</td>
<td><strong>Patterns</strong>&lt;br&gt;Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and factors that influence them.</td>
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<td>Analyzing and interpreting data (SEP4)</td>
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<td>Scientific investigations produce data that must be analyzed in order to derive meaning. Because data do not usually speak for themselves, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis to identify the significant features and patterns in the data.</td>
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<td>Constructing explanations (SEP6)</td>
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<td>Scientific explanations are explicit applications of theory to a specific situation or phenomenon, perhaps with the intermediary of a theory-based model for the system under study. The goal for students is to construct logically coherent explanations of phenomena that incorporate their current understanding of science, or a model that represents it, and are consistence with the available evidence.</td>
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<tr>
<td>Key Ideas and Details</td>
<td>Craft and Structure</td>
<td>Integration of Knowledge and Ideas</td>
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| **RST.9-10.1**  
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. | **RST.9-10.4**  
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics. | **RST.9-10.8**  
Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem. |
| **RST.9-10.2**  
Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. | **RST.9-10.5**  
Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy). | **RST.9-10.9**  
Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. |
| **RST.11-12.1**  
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. | **RST.9-10.6**  
Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. | **RST.11-12.8**  
Evaluate the hypotheses, data, analyses, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. |
| **RST.11-12.2**  
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. | **RST.11-12.4**  
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. | **RST.11-12.9**  
Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. |
## AP Science Standards

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<th>AP Statistics Content Standards</th>
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<td><strong>Science Practice 3 (SP3)</strong>&lt;br&gt;The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.</td>
<td><strong>Essential knowledge 2.A.4 (EK2.A.4)</strong>&lt;br&gt;In an experiment, different conditions (treatments) are assigned to experimental units (participants or subjects).</td>
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<td><strong>Science Practice 4 (SP4)</strong>&lt;br&gt;The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g. investigations, scientific observations, the findings of others, historic reconstruction, and/or archived data.)</td>
<td><strong>Essential knowledge 3.B.1 (EK3.B.1)</strong>&lt;br&gt;A well-designed experiment should include the following:&lt;br&gt;a. Comparisons of at least two treatment groups, one of which could be a control group.&lt;br&gt;b. Random assignment/allocation of treatments to experimental units.&lt;br&gt;c. Replication (more than one experimental unit in each treatment group).&lt;br&gt;d. Control of potential confounding variables where appropriate.</td>
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## Connections to the Nature of Science

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<th>Vision and Change for Undergraduate Biology Education Core Competencies and Disciplinary Practices</th>
<th>A Framework for K-12 Science Education Understandings About the Nature of Science</th>
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<tr>
<td><strong>Ability to understand the relationship between science and society (VC6)</strong>&lt;br&gt;Biologists have an increasing opportunity to address critical issues affecting human society by advocating for the growing value of science in society, by educating all students about the need for biology to address global problems, and by preparing the future workforce.</td>
<td><strong>Scientific Investigations Use a Variety of Methods (NS1)</strong>&lt;br&gt;Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.</td>
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