CAN INCLUSIVE STEM HIGH SCHOOL STRATEGIES REDUCE RACE AND GENDER GAPS IN SCIENCE ATTITUDES?

Findings Brief from the STEM School Study
INTRODUCTION

Despite some progress, gaps still exist between students of different race and gender—not only in employment in many STEM fields, but in STEM-related majors, achievement in STEM subjects, and attitudes towards STEM (Britner & Pajares, 2001; Martin, Mullis, Foy, & Hooper, 2016; National Center for Education Statistics, 2013; National Science Board, 2016; Riegle-Crumb, Moore, & Ramos-Wada, 2010). Many inclusive STEM high schools have a mission to serve students from groups currently underrepresented in STEM, such as girls, African American, and Hispanic students, in service of ultimately increasing interest and participation in STEM (Peters-Burton, Lynch, Behrend, & Means, 2014). In the studies described here, we investigated whether instructional and cultural strategies used by inclusive STEM schools were related to science attitudes and GPA for all students, and especially students from underrepresented populations.

Previous research on inclusive STEM schools has shown mixed results in outcomes for students attending STEM vs. non-STEM (traditional) schools. One reason for this may be that STEM schools focus on many different strategies and goals for students. The S3 team learned just how complex STEM schools can be when we interviewed inclusive STEM school leaders across the U.S. to develop the 8 Elements of Inclusive STEM High Schools, a framework which represents the common goals of inclusive STEM high schools, as well as the numerous strategies that they employ to reach those goals. The 8 Elements are: Rigorous Learning; Personalization of Learning; Problem-Based Learning (PBL); School Community and Belonging; Career, Technology, and Life Skills; External Community; Staff Foundations; and Essential Factors. More detail on the framework and each of the 8 Elements can be found at outlier.uchicago.edu/s3.

After developing the 8 Elements framework, we wanted to know, do these strategies work? And, do they work to help the underrepresented populations that many inclusive STEM schools target?
We wanted to get INTO the “black box” of STEM schools to understand how specific strategies may relate to critical student outcomes.

We began by looking at a subset of the student-facing strategies (that is, those that directly address the schools’ goals for students) that are important to STEM school models: problem-solving projects, supportive relationships, student culture, student cooperation and teamwork, student autonomy, interdisciplinary connections, teacher facilitation of student interest, cognitively demanding work. Each of these strategies is associated with one or more of the 8 Elements.

For these analyses, we looked at how the implementation of these strategies relates to students’ science-related attitudes (intrinsic motivation and beliefs about their science abilities), their interest in future STEM careers, and their overall cumulative GPAs.

**Methods:** The data for these analyses comes from 17 schools that participated in our Year 3 (Spring 2015) questionnaire data collection. Students from all grades participated, with a total sample of 2,943 students for the analyses focused on problem-solving projects, supportive relationships, and student culture (944 with GPA data), and 433 students included in the analyses looking at instructional practices (student cooperation and teamwork, student autonomy, interdisciplinary connections, teacher facilitation of student interest, cognitively demanding work) in science classes.

Multiple regression analyses were used to examine associations between strategies used by STEM school and student outcomes, and interaction terms were included to explore whether these associations varied by students’ racial/ethnic and gender identities. A positive response bias measure (general intrinsic motivation for schoolwork) was also used as a control variable.
FINDINGS

Across inclusive STEM high schools, race and gender gaps in science attitudes and cumulative GPA remain prevalent.

Black and Hispanic students reported significantly lower science intrinsic motivation than White students. Black students reported significantly lower science ability beliefs than White students, and Black students reported significantly lower interest in future STEM careers than Hispanic students.

Black students had significantly lower cumulative GPAs than White students.

*Significant difference compared to White students at p<.05 or lower.
**Significant difference compared to Hispanic students at p<.05 or lower.
While girls (female-identified students) had significantly higher cumulative GPAs than boys (male-identified) students, girls reported significantly lower scores on all three science attitude beliefs than boys.

*Significant difference (lower) compared to boys at p<.05 or lower.
**Significant difference (higher) compared to boys at p<.05 or lower.

However, we found that student ratings of certain strategies used by inclusive STEM school predict science attitude outcomes and GPA.

When students reported high ratings of certain strategies (in particular, problem-solving projects, student culture, and autonomy in the classroom) there were reduced race and gender gaps on science attitudes and GPA. Findings for each strategy are described in the following pages.

It should be noted that these findings are exploratory, and should be interpreted cautiously. As per IES guidelines for exploratory findings, these analyses do not incorporate multiple testing corrections (e.g., Bonferroni corrections).
What are Science Attitudes?

*Science attitudes* refer to students' personal feelings about science and STEM careers.

**Science Intrinsic Motivation** measures students' science "interest." Students reporting high scores on science intrinsic motivation responded positively to items like "Learning about science is fun," and "I enjoy science investigations."

**Science Ability Beliefs** measures students' science "confidence." Students reporting high scores on science ability beliefs responded positively to items like "I have the skills and ability to learn science," and "I'm better at science than most of the other kids in my school."

**Interest in Future STEM Careers** means that students responded positively to items such as "I seem myself pursuing a career in STEM," and "I plan to take a lot of STEM courses in college."
Problem-solving projects

Students engage in projects that incorporates a number of learning goals, including collaborative problem-solving, research, discussion, career content, interdisciplinary opportunities, and relevance to students’ lives.

Positive student ratings of problem-solving projects were significantly associated with higher science intrinsic motivation, science ability beliefs, and interest in a future STEM career for all students.

High student ratings of problem-solving projects were significantly associated with a reduced gap in science ability beliefs for Black and White students (Figure 1a), as well as reduced gaps between Hispanic and White students on Interest in a Future STEM Career (Figure 1b).
Student culture

*Students treat each other with trust and respect, students demonstrate a code of behavior and values, and students contribute to school decision-making*

Positive student ratings of student culture were significantly associated higher science intrinsic motivation, science ability beliefs, interest in future STEM careers, and GPA for all students.

High ratings of student culture were significantly associated with reduced gaps in science intrinsic motivation between Black and White students (Figure 2a) and between Hispanic and White students (Figure 2b).

High ratings of student culture were significantly associated with reduced gaps in science ability beliefs between Black and White students (Figure 2c) and between Hispanic and White students (Figure 2d).

High ratings of student culture were significantly associated with a higher GPA for all students. In addition, Hispanic students who reported low levels of student culture had significantly lower GPAs than White students. Hispanic students who reported high levels of student culture had significantly higher GPAs than White students (Figure 2e).
Supportive Teacher Relationships

Students believe that teachers work hard to ensure that students feel comfortable talking with them about personal problems, that they understand students’ lives, and that they support students’ emotional needs.

Positive student ratings of supportive adult relationships were significantly associated with higher science ability beliefs, interest in future STEM careers, and GPA for all students.

High ratings of supportive relationships were significantly associated with a reduced gap in science intrinsic motivation between Black and White students (Figure 3a).

High ratings of supportive relationships were significantly associated with a reversed relationship between ethnicity and GPA for Hispanic and White students. When students reported strong adult relationships in their schools, Hispanic students had higher cumulative GPAs than White students (Figure 3b).
Student Autonomy in Science Class

*Students have independence in and ownership of their learning, as well as skills such as organization and self-regulation.*

Girls appear to be the only group to benefit significantly from more highly rated autonomy in science classes. **High ratings of student autonomy in science class were linked to a reduced gap between female-identified students and male-identified students for both science intrinsic motivation (Figure 4a) and science ability beliefs (Figure 4b).**
Cognitive Demand in Science Class

Students engage in process and thinking skills in science lessons. This includes considering alternative arguments or explanations, making predictions, interpreting their experiences, analyzing data, explaining their reasoning, and supporting their conclusions with evidence.

Black students appear to be the only group to benefit significantly from more highly rated cognitive demand in science classes. High ratings of cognitive demand in science class were linked to a reduced gap in science intrinsic motivation between Black and White students (Figure 4c).
Interdisciplinary Content in Science Class

Students identify ways that disciplines are interrelated, reinforced, and complement one another.

Girls appear to be the only group to benefit significantly from more highly rated interdisciplinary content in science classes. **High ratings of interdisciplinary content in science class were linked to a reduced (reversed) gap in science ability beliefs between female-identified students and male-identified students (Figure 4d).**
Teacher Facilitation of Student Interest in Science Class

*Students believe that teachers make science lessons interesting, fun, and relevant to their lives.*

Positive student ratings of teacher facilitation of student interest in science class were significantly associated with higher science intrinsic motivation for all students.

High ratings of teacher facilitation of student interest in science class were linked to a reduced gap between Hispanic and White students (Figure 4e).
Technology Use in Science Class

Students use innovative technology for science lessons, and have sufficient technological resources necessary to complete schoolwork.

Black students appear to be the only group to benefit significantly from more highly rated technology use in science classes. High ratings of technology use in science class were linked to a reduced gap in science intrinsic motivation between Black and White students (Figure 4f).
WHY IS THIS IMPORTANT?

Across our national sample of inclusive STEM high schools, statistically significant race and gender gaps in science attitudes and GPA remain.

While inclusive STEM schools may be admitting students underrepresented in STEM, they do not necessarily show equity in outcomes across race and gender. We need to move the goal of inclusive STEM schools beyond ACCESS for all students, and toward SUCCESS for all students. How do we do this?

This research may suggest that simply having a given strategy in place may not be enough. While many schools and classrooms in our study value the 8 Elements strategies, they vary greatly in how they enact these strategies.

It’s only when students report high ratings of some of the 8 Elements strategies that we begin to see reduced gaps across race and gender—that is, that we see attitude and achievement gaps closing.

These findings are exploratory and non-causal, and should be interpreted cautiously. One explanation may be that more positive students are equally likely to report both more positive STEM attitudes as well as more positive experiences with STEM school strategies. We did our best to control for this potential by including a positive response bias control. This control variable, general intrinsic motivation for schoolwork (i.e. “I enjoy schoolwork, I find my schoolwork interesting”, etc.) did show powerful predictions of student attitudes toward STEM. However, even with this control variable in place, we found that the implementation of certain STEM strategies maintained unique prediction of some reduced race and gender gaps.

It’s also important to note that more rigorous Bonferroni correctional tests of these same findings reduce significant differences (LaForce et al., under review). All of these exploratory findings are presented here for further consideration and hypothesis testing. Additional research is needed to better understand the practical differences across race and gender, and how implementation of STEM school strategies may affect these gaps in the STEM pipeline.
REFERENCES


Questions? Contact Melanie LaForce at laforce@uchicago.edu.

*Suggested citation:*

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