Researchers find common traits that account for strong STEM outcomes in schools

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Five years ago, researchers at the George Washington University, SRI International and George Mason University began a study of inclusive science, technology, engineering and math (STEM) high schools that target underrepresented minority students. The National Science Foundation-funded study, "Opportunity Structures for Preparation and Inspiration," is nearly complete and researchers have identified 14 critical components that eight exemplary inclusive STEM high schools had in common. They also prepared a toolkit to help schools self-assess their STEM programs, using the inclusive STEM schools in this study as exemplars.

These findings are significant because the eight study schools were spread across the U.S. and had no formal affiliations with one another. The schools chosen for this study had near-100 percent high school graduation and college admissions rates. They had a common mission to help students achieve STEM success, especially females and minority students, students from families of modest means and students who were the first generation in their families to attend college. Inclusive STEM high schools are different than the highly selective STEM-focused schools that target students who are already identified as gifted and talented in STEM.

In addition to preparing students for careers and college, this research shows that the schools studied had created curricular, instructional and organization structures that don't match notions of traditional high schools.

"Inclusive STEM schools aren't like most private schools, but are not really like traditional comprehensive schools either," said Sharon Lynch, professor of curriculum and pedagogy at GW's Graduate School of Education and Human Development and the principal investigator for the study. "This is a new kind of school that is much more inclusive and is bringing in students who want to be there and study STEM, no matter their backgrounds. They have figured out how to do things differently, to trust their students to achieve and their teachers to guide students toward STEM college majors."

Major Findings: What Made the STEM High Schools Studied Different?

The inclusive STEM high schools studied in this project had 14 critical components in common that distinguished them from traditional high schools and from STEM-focused high schools without an inclusive mission. The critical components are:

1. College-prep, STEM-focused curriculum for all
2. Well-prepared STEM teachers with strong—sometimes professional—background in STEM
3. Supports for underrepresented students
4. Flexible and autonomous administration
5. Reformed instructional strategies and project-based learning
6. Integrated, innovative technology use
7. STEM-rich, informal experiences
8. Connections with business, industry and the world of work
9. College-level coursework
10. Inclusive STEM mission
11. Dynamic assessment systems for continuous improvement
12. Innovative and responsive leadership
13. Positive school community and culture of high expectations for all
14. Student agency and choice

Among these 14 components, four critical components stood out as consistently prominent. The schools required all students to pursue STEM-focused college preparatory curricula. All students received high-quality learning experiences that prepared them for college STEM majors. This included mathematics through pre-calculus or calculus, a science sequence with chemistry and physics, and coursework in engineering, technology, or STEM career technical education classes.

Second, every successful STEM school had well-qualified teachers with strong STEM backgrounds, some had business/industry and research experience, others were well-prepared to teach through strong teacher preparation programs. STEM teachers were collaborative and worked with school leaders to develop innovative STEM programs of study. They also had humanities teachers who integrated STEM into their classes.

Third, because these STEM high schools had admissions by lottery and admitted a wide range of students, students naturally needed support for the demanding STEM programs. Students had access to a variety of virtual and in-person tutoring, joined study groups, and had online data systems to help monitor their progress and access help.

Finally, the schools in this study had achieved some degree of autonomy from school district level policies, and were free to innovate. Two of the eight schools were charter schools, but the rest were not. Because these high schools were relatively small—with 350 to 600 students—they could be nimble in making decisions to create new kinds of instructional challenges that required students to work across STEM fields.

A Toolkit for Success

The researchers developed several resources, including a logic model and accompanying STEM Inventory—tools for schools to self-assess their

STEM programs. The study's website contains detailed case studies of the eight schools, "day in the life" narratives of students in comprehensive and inclusive STEM high schools, and links to scholarly publications and to other STEM education resources.

As supplements to scholarly publications developed throughout this study, researchers also created a set of three videos focusing on one of the study schools, Metro Early College High School in Columbus, Ohio. The videos provide an overview of this school and share the "day in the life" experiences of two students, one sophomore and one junior. Both students attended college as well as high school, and the junior was working on a research study at a nearby children's hospital.

Day in the Life Studies of Students

A second phase of the research focused on "Day in the Life" studies of students who attended STEM high schools and those who attended nearby comprehensive traditional high schools. Researchers captured what it felt like to be a high school student who was learning about STEM at these two types of schools—from the moment the student arrived in the morning to the end of the day.

Researchers visited two traditional comprehensive high schools and two inclusive STEM high schools, and shadowed students for two days, documenting their classroom activities and their interactions with peers. This shed light on differences in student experiences with instruction and curriculum and the different relationships students had with each other and with teachers.

At the comprehensive schools there was more direct instruction and teacher lectures, accompanied by individual student work at their desks. At the inclusive STEM high schools students worked more in groups, could discuss and explain what they were learning and apply it to real

world contexts. They seemed more excited about learning. They also had more developed college and career plans, whether they were aiming for STEM careers or not.

Schools Included in the Study

The research group identified eight inclusive STEM schools with successful track records. A group of STEM school experts who knew the schools by reputation nominated the schools. Consideration was given to schools that are highly racially diverse with approximately equal numbers of male and female students and with high proportions of low income families. All are schools of choice, meaning that the students chose to attend with admission through a lottery system. Test scores, graduation rates and college admissions rates were far above the state averages, and they served all portions of their populations well. Some had won awards for high achievement and had been recognized in STEM competitions.

The participating schools are: Manor New Technology High School (Texas); Wayne School of Engineering (North Carolina); Dozier-Libbey Medical High School (California); Denver School of Science & Technology: Stapleton High School (Colorado); Urban Science Academy (Massachusetts); Metro Early College High School (Ohio); The Gary and Jerri-Ann Jacobs High Tech High (California); and Chicago High School for Agricultural Sciences (Illinois).

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