Ending the Double Disadvantage

ENSURING STEM OPPORTUNITIES IN OUR POOREST SCHOOLS

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CHANGE THE EQUATION™

STEM Deserts

Schools are becoming more segregated by income, and the consequences for STEM education will be dire. Poor children in the United States are more and more likely to attend schools where most of their peers are poor as well,[1] and this dynamic can have devastating effects on education.[2]

What sort of effects? Change the Equation dug into survey data from the 2015 Nation's Report Card to find out. We examined gaps between students who attend the lowest-poverty schools (where no more than 25 percent of students qualify for lunch at no cost or a reduced price) and highest-poverty schools (where at least 75 percent of students qualify).

The story these data tell is straightforward and troubling: At every stage of their K-12 education, students who attend the highest-poverty schools are least likely to have access to STEM resources, experiences, and classes most wealthy parents would demand for their children. As a result, students in such schools suffer disadvantage upon disadvantage over the course of their schooling, and they face dim prospects for rewarding STEM careers.

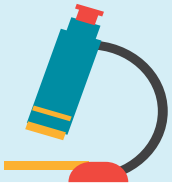
These findings confirm decades of research on the especially heavy toll concentrated poverty takes on student opportunities and achievement.[3] If recent trends persist, the inequities may deepen. Federal data show that schools where at least 76 percent of students qualify for free or reduced-price lunch made up 25 percent of all public schools in 2014,[4] up from just 12 percent in 1999.[5] In the 2014/2015 school year, almost one in four public school students—more than 12 million—attended such schools.[6]

Decades of economic segregation are difficult to undo through education policy alone, but state and education leaders can adopt proven policies and strategies for boosting opportunities in schools with the highest concentrations of poverty. The alternative—squandering the talents of so many millions in these schools—invites a moral and economic calamity.

Disparities in Elementary School

Children in the highest-poverty elementary schools have fewer opportunities than their peers in wealthier schools. These disparities are most evident in elementary science, which for decades has been the largely forgotten stepchild of school reform.

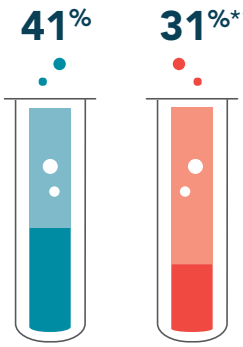
Overall, American fourth-graders lack access to space or materials for science lab activities. The situation in the lowest-poverty schools is grim enough, but it is even worse in the highest-poverty schools:



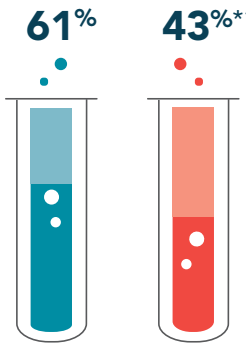
Fourth-graders in the poorest schools have less access to science labs and materials

Schools with the highest concentration of students from low-income families are much less likely to provide space for science labs or equip those labs with supplies and materials.

Percentage of 4th-graders whose schools provide space to conduct science labs, 2015*



Percentage of 4th-graders whose schools provide supplies or equipment for science labs, 2015*



* Shows percent who answered "to a moderate extent" or"to a large extent."

** Statistically significant different from ≤25%-poverty schools.

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 4th-Grade Science Assessment, 2015

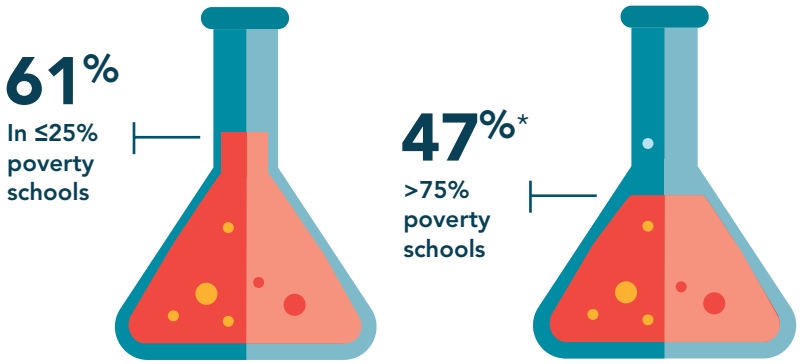
NOTE: Questions: "To what extent does your school system (including your school and school district) provide space to conduct sience labs? Supplies or equipment for science labs? (teacher reported: Not at all, Small extent, Moderate extent, Large extent)." "≤25% schools" are schools where 25% or less of students are eligible for free or reduced-price lunch. ">75% schools" are schools where more than 75% of students are eligible for free or reduced-price lunch.

It is hardly surprising that fourth-graders who have least access to space and supplies for science labs are also least likely to do weekly hands-on science activities:

Hands-on science gets short shrift in high-poverty elementary schools

Students in these schools are much less likely than their peers in wealthier schools to experience hands-on activities in science. More than half miss out on these critical opportunities to build early interest and mastery.

Percentage of fourth-graders who do **hands-on science** activities at least once per week, 2015



* Statistically significant difference from ≤25%-poverty schools

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 4th-Grade Math and Science Assessments, 2015

NOTE: Survey questions: "About how often do your science students do hands-on activities or investigations in science? (Teacher-reported: Never or hardly ever, Once or twice a month, Once or twice a week, Every day or almost every day.)" Flask icon adapted from Freepik from www.flaticon.com is licensed by CC 3.0 BY.

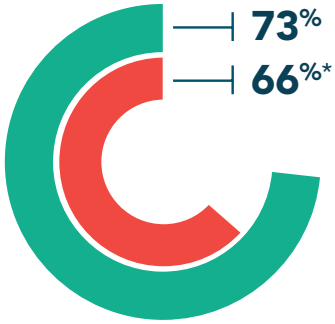
Teachers in high-poverty elementary schools are also most likely to say that they lack the materials they need to teach. Only 44 percent of fourth-graders in the highest-poverty schools, compared with 61 percent of their peers in the lowest-poverty schools, have teachers who report having "all" or "most" of the resources they need.

The Nation's Report Card did not ask fourth-grade teachers about teaching materials for science, but it did include a question about materials for math. There, too, the data reveal a gap between the lowest- and highest-poverty elementary schools:

Teachers in the poorest elementary schools lack teaching resources for math

Children who attend elementary schools where most students qualify for free or subsidized lunches are much less likely to have teachers who receive the resources they need to teach math.

Fourth-graders whose teachers have "all" or "most" of the resources they need to teach math, 2015



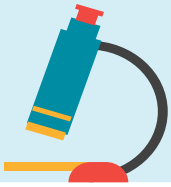
* Statistically significant difference from ≤25%-poverty schools

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 4th-Grade Mathematics Assessment, 2015

NOTE: Survey question: "Which of the following statements best describes how well your school system supplies you with the materials and other resources you need for mathematics instruction? (Teacher-reported: None, Some, Most, All)."

The Disparities Continue in Middle Schools

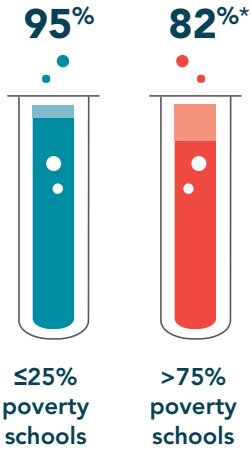
Students who go on to enroll in the highest-poverty middle schools face very similar disparities. Here again, such students are most likely to lack space and materials for science labs:



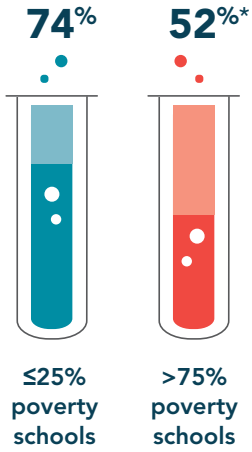
Eighth-graders in the poorest schools have much less access to science labs and materials

Schools with the highest concentration of students from low-income families are much less likely to provide science labs or equip them with supplies and materials.

Percentage of 8th-graders whose schools provide science labs, 2015



Percentage of 8th-graders whose schools provide ample supplies or equipment for science labs, 2015



* Statistically significant different from ≤25%-poverty schools.

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 8th-Grade Science Assessment, 2015

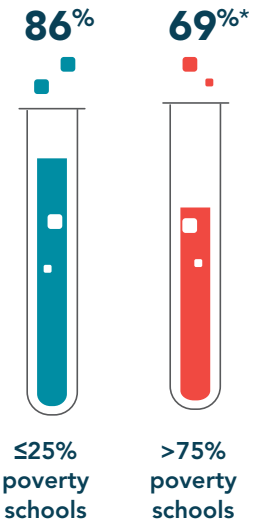
NOTE: Questions: "Does your schol have laboratory facilities for eighth-grade science instruction? (School-reported: Yes, No)." "To what extent does your school system (including your school district) provide supplies or equipment for science labs? (Teacher-reported: Not at all, Small extent, Moderate extent, Large extent.)" Chart shows percentage who answered "large extent."

Students in the highest-poverty middle schools are also least likely to do hands-on activities, or to discuss the results of such activities:

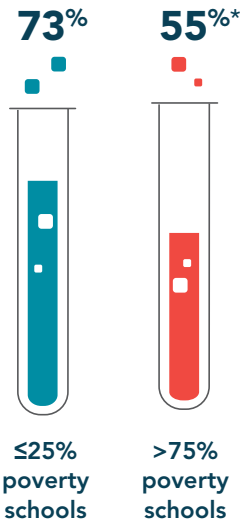
Hands-on science gets short shrift in high-poverty middle schools

Students in schools with the highest concentrations of poverty are less likely than those in wealthier schools to experience hands-on activities in science. They are also much less likely to talk about the results of such activities.

Eighth-graders who do hands-on science activities every week, 2015



Eighth-graders who discuss the results of such activities every week, 2015



* Statistically significant different from ≤25%-poverty schools.

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 8th-Grade Science Assessment, 2015

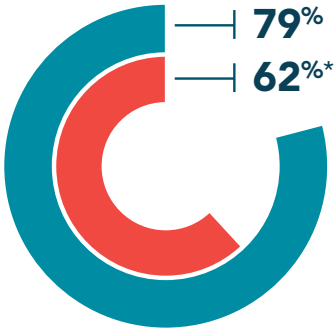
NOTE: Survey questions: "About how often do your science students do hands-on activities or investigations in science?" "About how often do our science students talk about the measurement and results from students' hands-on activities? (Teacher-reported: Never or hardly ever, Once or twice a month, Once or twice a week, Every day or almost every day.)"

Teachers in the highest-poverty middle schools are much less likely than their peers in wealthier schools to have the instructional supplies and materials they need:

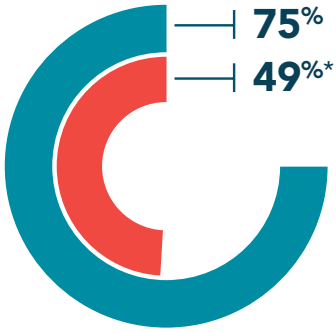
Teachers in the poorest middle schools lack teaching resources for math and science

If you attend a middle school where more than 75 percent of students qualify for free or subsidized lunches, your teachers are much less likely to have the resources they need to teach math and science.

Eighth-graders whose teachers have "all" or "most "of the resources they need to teach **math**, 2015



Eighth-graders whose teachers have "all" or "most "of the resources they need to teach **science**, 2015



In ≤25% poverty schools >75% poverty schools

* Statistically significant difference from ≤25%-poverty schools

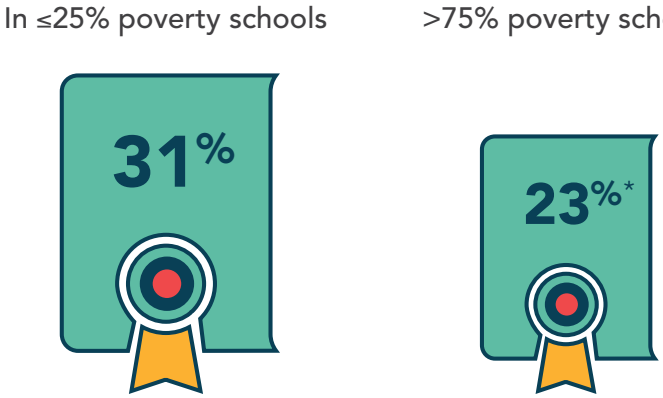
SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 8th-Grade Math and Science Assessments, 2015

NOTE: Survey questions: "Which of the following statements best describes how well your school system supplies you with the materials and other resources you need for mathematics instruction? (Teacher-reported: None, Some, Most, All)." "Which of the following statements best describes how well your school system supplies you with the materials and other resources you need for science instruction? (None, Some, Most, All.)"

These teachers can use all the support they can get, especially in math. Math teachers in the highest-poverty middle schools are less likely than their peers in wealthier schools to have an undergraduate degree in the subject:

Students in the poorest middle schools have least access to qualified teachers

Percentage of 8th-graders whose teachers have undergraduate majors in mathematics, 2015



* Statistically significant difference from ≤25%-poverty schools

SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 8th-Grade Math and Science Assessments, 2015

NOTE: Survey questions: "Which of the following statements best describes how well your school system supplies you with the materials and other resources you need for mathematics instruction? (Teacher-reported: None, Some, Most, All)." "Which of the following statements best describes how well your school system supplies you with the materials and other resources you need for science instruction? (None, Some, Most, All.)"

Gaps in Access to Challenging High School Courses

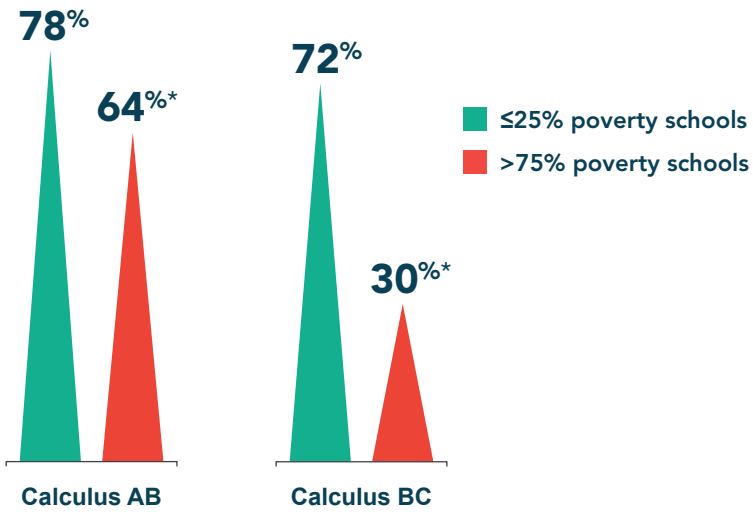
In high schools, NAEP data reveal large disparities in access to high-level courses in STEM fields.

Twelfth-graders in the highest-poverty schools are less likely to have access to AP calculus courses:

Students in the poorest high schools have least access to AP calculus

The disparities are largest in Calculus BC, which covers more content than Calculus AB.

Percentage of 12th-graders whose high schools offer Advanced Placement Calculus, 2015



* Statistically significant different from ≤25%-poverty schools.

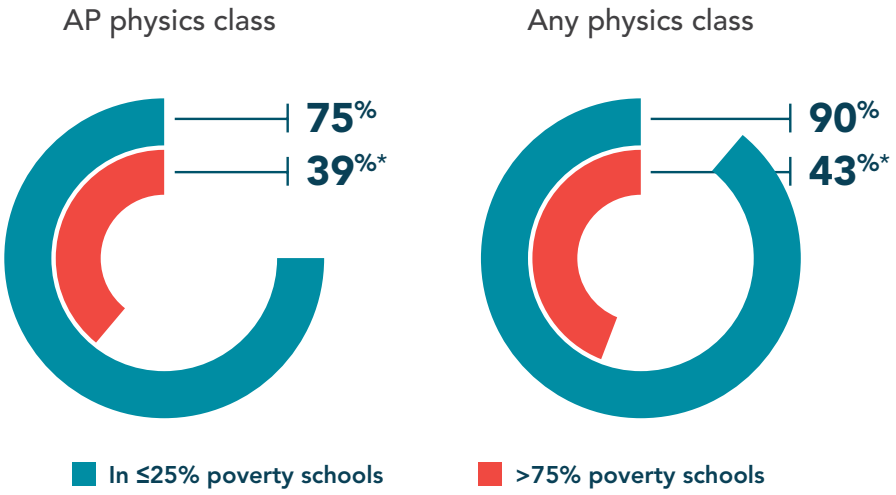
SOURCE: CTEq analysis of data from the U.S. Department of Education, National Assessment of Educational Progress, 2015 12th-grade Mathematics Assessment

NOTE: Survey questions: "Are courses of at least one semester in length taught in your school in: Advanced Placement (AP) Calculus AB; Calculus BC? (School-reported: Yes, No.)"

Students who attend the highest-poverty high schools are also much less likely to have access to physics classes:

Students in the poorest high schools have least access to physics

Percentage of 12th-graders whose schools offer physics classes, 2015



* Statistically significant difference from ≤25%-poverty schools

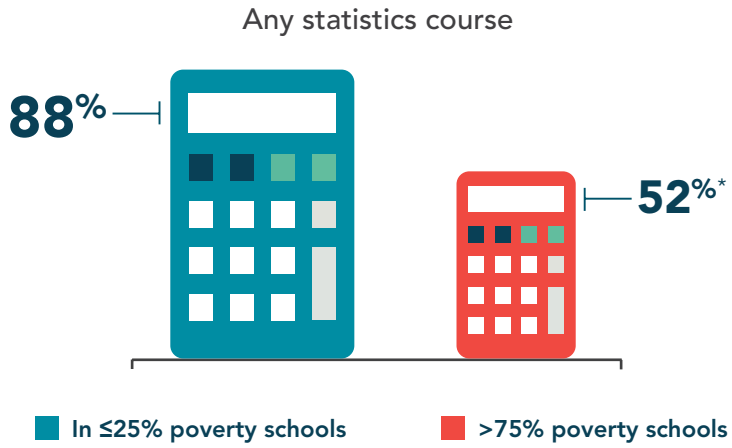
SOURCE: CTEq analysis of U.S. Department of Education, National Assessment of Educational Progress 12th-Grade Science Assessment, 2015

NOTE: Survey questions: "Are courses of ate least one semester in length taught at your school in: Advanced Placement (AP) Physics? Advanced physics other than AP? (School-reported: Yes, NO)." "Any physics class" includes AP physics and "Advanced physics," but not Internaational Baccalaureate physics, which reaches only 7 percent of low-poverty and 2 percent of high-poverty schools.

The same pattern holds for statistics and computer science classes:

Students in the poorest high schools have the least access to statistics

Percentage of 12th-graders whose high schools offer statistics classes, 2015



* Statistically significant difference from ≤25%-poverty schools

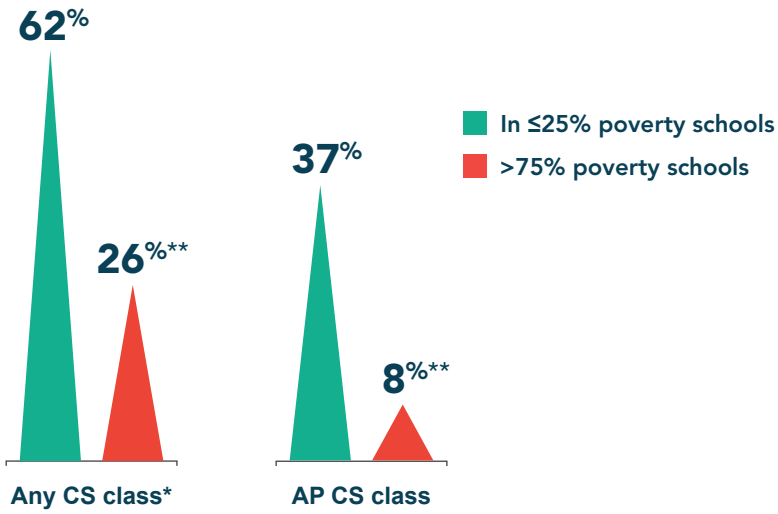
SOURCE: CTEq analysis of data from the U.S. Department of Education, National Assessment of Educational Progress, 2015 12th-grade Mathematics Assessment.

NOTE: Survey questions: "Are courses of at least one semester in length taught in your school in: Advanced Placement (AP) Statistics; Probability/statistics (other than AP)? (School-reported: Yes, No.)" "Any statistics course" refers to AP and non-AP statistics courses

The disparities in computer science are breathtaking:

Students in the poorest high schools have least access to computer science

Percentage of 12th-graders whose high schools offer computer science classes, 2015



* Includes AP and non-AP classes

** Statistically significant different from ≤25%-poverty schools.

SOURCE: CTEq analysis of data from the U.S. Department of Education, National Assessment of Educational Progress, 2015 12th-grade Mathematics Assessment

NOTE: Survey questions: "Are courses of at least one semester in length taught in your school in: Advanced Placement (AP) Computer Science A; computer science (other than AP)? (School-reported: Yes, No.)"

Making high-poverty a high priority

To accept the status quo is to consign one in four U.S. school children to a very uncertain future while depriving the workforce of vital talent. Any STEM policy should make the highest-poverty schools an explicit priority.

To be sure, these inequities elude quick fixes. It would be all too easy to blame the plight of students in the highest-poverty schools on feckless educators or scheming politicians, but such unjust oversimplifications would distract us from the urgent work ahead. Economic segregation stems from complex causes with deep historical roots, such as income inequality, perverse housing policies, the loss of stable industrial and agricultural jobs, barriers to medical care, and institutional racism. The highest-poverty schools, which suffer the worst consequences of this legacy, often face pressures to comply with minimum standards at the expense of a richer vision of education. Of course, minimum standards are not good enough.

One critical first step in addressing these inequities is to measure and report them. Federal data have allowed Change the Equation to illuminate grim inequities at a national level, but solid data on STEM opportunities in schools with concentrated poverty are scarce for individual states, districts, or schools.

States and districts should keep a close eye on what opportunities students at those schools have to learn. Do their teachers have strong STEM backgrounds, such as majors in the field they teach, for example? Do teachers have access to strong curriculum and lesson plans aligned to standards? Do students have access to supplies and equipment that support the curriculum? Do they have access to challenging STEM courses? If we turn a blind eye to these issues, then we're betting on miracles.

Solutions

Fortunately, states, districts, and schools can adopt concrete strategies to address the inequities they observed. Those strategies can benefit all schools, but they are especially suited to expanding opportunity in the nation's poorest schools.

For example:

- Make science a priority by including it in state accountability systems. In most U.S. states, the highest-poverty schools have faced especially intense pressure to raise students' performance in mathematics and reading, allowing science to fall by the wayside. If science gets measured, it's more likely to get taught.
- Make more STEM equipment and supplies available to schools that need them most. Initiatives like ASSET STEM Education, Science in Motion, and the Amgen Biotech Experience have supplied struggling schools with STEM education materials from central warehouses. They have also trained teachers on how to use those materials well.
- Keep an eye on technological innovations such as virtual reality, which could make authentic "hands-on" STEM experiences dramatically cheaper and more accessible. One Washington, DC high school is already creating an open source virtual reality Chemistry lab it hopes schools across the country will adopt. Such innovations cannot take hold overnight, but they have the power to transform science education.
- Help colleges of teacher education improve the STEM knowledge of their graduates. Programs like UTeach allow top college students in STEM earn their teaching certifications while they complete degrees in STEM fields, without adding months or years to their college careers. Two-thirds of UTeach programs' more than 3,000 graduates currently teach at schools where most students receive free or reduced-price lunch. The average student of a UTeach graduates gains the equivalent of months of additional schooling in math and science.[7]
- Give teachers in the highest-poverty schools excellent curriculum and teaching materials aligned to support state standards. New science standards that emphasize authentic, hands-on investigations are giving rise to new curricula, lesson plans, activity plans, and other materials. States, districts, and schools can use resources like CTEq's STEMworks honor roll of effective programs, and Achieve's EQuIP rubric, to separate the wheat from the chaff.

- Help the highest-poverty high schools offer challenging STEM courses. Initiatives like the College Readiness Program establish AP courses in high schools and then give students, teachers, and other staff the support they need to meet the rigorous demands of these courses. These programs boast sharp increases in the number of students who take AP classes and succeed on AP tests.[8] States across the country have also launched Computer Science for All initiatives that could build a stronger platform for AP computer science in high schools with high concentrations of poverty.
- Support top-quality afterschool STEM programs in the nation's poorest communities. Afterschool programs can help fill in gaps in opportunities offered by schools. Surveys of parents suggest that those in the highest-poverty communities would welcome more afterschool STEM options for their children.[9]

None of these approaches is easy, and none alone can heal all the inequities Change the Equation's analysis revealed. Together with a strategy to assess schools' STEM needs, however, they can mitigate the effects of concentrated poverty.

Advocates for STEM education have made a convincing case that STEM careers are a critical gateway to individual and national prosperity. For millions of students who attend the nation's poorest schools, those gates are closed.

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1 A. Owens, S. F. Reardon, and C. Jencks, "Income Segregation Between Schools and School Districts," *American Educational Research Journal* 53, no. 4 (2016).

2 Janie Boschma and Ronald Brownstein, "The Concentration of Poverty in American Schools," The Atlantic, February 29, 2016.

3 Roslyn A. Mickelson & Martha Bottia, "Integrated Education and Mathematics Outcomes: A Synthesis of Social Science Research," *North Carolina Law Review* 88, no. 4 (2010), 993-1090.

4 U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), " Public Elementary/Secondary School Universe Survey," 1999-2000 through 2014-15. (This table was prepared October 2016), accessed June 22, 2017, https://nces.ed.gov/programs/digest/d16/tables/dt16_216.30.asp.

5 S. Aud, w. Hussar, M. Planty, T. Snyder, K. Bianco, M. Fox, L. Frohlich, J. Kemp, and L. Drake, *The Condition of Education 2010* (NCES 2010-028), National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC, 2010. accessed June 22, 2017, https://nces.ed.gov/pubs2010/2010028.pdf

6 U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2014-15. (This table was prepared October 2016), accessed June 22, 2017, https://nces.ed.gov/programs/digest/d16/tables/dt16_216.60.asp. The share of students eligible for free and reduced-price lunch rose at a slower rate over the same period—from roughly 38 to 52 percent of all public school students. U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2000-01, 2010-11, 2013-14, and 2014-15. (This table was prepared March 2017), accessed June 22, 2017, https://nces.ed.gov/programs/digest/d16/tables/dt16_204.10.asp.

7 Benjamin Backes, Dan Goldhaber, Whitney Cade, Kate Sullivan, Melissa Dodson, "Can UTeach? Assessing the Relative Effectiveness of STEM Teachers," CALDER, December 01, 2016, accessed June 22, 2017, http://www.caldercenter.org/publications/can-uteach-assessing-relative-effectiveness-stem-teachers.

8 D. Sherman, M. J. Darwin,M. Song, Y. Li., and S. Stachel, "First-Year impacts of the National Math and Science Initiative's Advanced Placement Training and Incentive Program on high school students' outcomes," Paper presented at the 2015 annual meeting of the American Educational Research Association, accessed June 26, 2017, http://www.aera.net/Publications/Online-Paper-Repository/AERA-Online-Paper-Repository/Owner/616329.

9 Afterschool Alliance, "Afterschool in Communities of Concentrated Poverty," America After 3pm Special Report, August 2016. Accessed June 24, 2017, http://www.afterschoolalliance.org/AA3PM/Concentrated_Poverty.pdf.

Change the Equation (CTEq) works at the intersection of business and education to ensure that all students are STEM literate by collaborating with schools, communities, and states to adopt and implement excellent STEM policies and programs. CTEq's coalition of business leaders are working toward universal STEM literacy by advocating for state policies and practices that are known to produce STEM-literate high school graduates; ensuring high standards for all students; and supporting evidence-based high quality STEM learning programs.

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