# Increasing Student Access to Rigorous STEM Learning

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A guidebook for high schools from the National Math + Science Initiative

NATIONAL MATH + SCIENCE INITIATIVE

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## EXECUTIVE SUMMARY

Proficiency in math and science is critical for the nation's economic growth, yet a growing number of students lack foundational knowledge and skills in these subject areas. According to one estimate, only 41% of U.S. high school graduates were ready for college-level math in 2016, and only 36% were ready for college-level science.<sup>1</sup> The issue is even more pronounced for traditionally underserved students whose ability to access rigorous coursework is often limited.

The National Math + Science Initiative aims to address this significant challenge by creating increased opportunities and better outcomes for all students. NMSI views Advanced Placement<sup>®</sup> courses as a key vehicle for engaging high school students of all backgrounds in highquality STEM education and promoting college readiness because AP<sup>®</sup> offers a rigorous teaching framework, as well as a consistent assessment, across the globe.

NMSI's College Readiness Program provides teacher, student, and school supports to promote high school students' success in English, math, and science AP courses, with a particular focus on traditionally underrepresented students. The program is based on the premise that more students—and especially high-need students—can master rigorous AP coursework with the right supports in place. These supports include teacher training and mentoring; additional instructional time for students outside the classroom; instructional resources; vertical teaming and funding for purchasing equipment and supplies.

"Our teachers have received a great deal of professional development and have collaborated with great teachers around the nation," one partner school director said. "This has dramatically changed instruction in the classroom."

Through a scale-up grant from the U.S. Department of Education's Investing in Innovation (i3) program, NMSI implemented CRP in 27 schools in the 2016-17 school year and in another 21 schools in the 2017-18 school year. The National Center for Research on Evaluation, Standards, and Student Testing (CRESST) conducted an independent evaluation of the program's impact using a randomized cluster trial with these 48 CRP schools and also 48 comparison schools in 10 states.<sup>2</sup> The findings revealed that students in the CRP schools were significantly more likely to take an AP exam—and the program also helped change the culture at participating schools.

This guidebook summarizes the research findings, and it reveals bestpractice lessons that have emerged from the program. These lessons can help other schools throughout the nation increase the STEM achievement and college readiness of all students, but especially those who are currently underrepresented.

NMSI's services to schools and communities can be funded through private, local, state and federal funds, including Elementary and Secondary School Emergency Relief (ESSER) resources.



## **KEY FINDINGS**

#### The College Readiness **Program helped transform** the culture at participating schools

The majority of teachers and administrators felt their school culture had changed in a positive way from implementing the program. Teachers also believed their school's administration promoted a culture of continuous improvement and valued STEM learning at a higher rate.

### CRP led to increased participation in AP courses and exams

Schools participating in NMSI's CRP significantly increased the probability of their students taking an AP course and exam when compared to matched. similar schools. What's more. the program played a key role in creating more equitable opportunities for all students to experience rigorous, college-level work.

#### Teachers' skills in teaching rigorous STEM content increase

A majority of teachers said CRP contributed to a "major" improvement in both their content knowledge and their instructional skills and strategies. Administrators echoed these sentiments, and students overwhelmingly agreed that their AP teachers understand the content they're teaching.



### Students became more confident in their own abilities

Students who participated in CRP expressed a high degree of confidence in their ability to complete AP courses, learn STEM content, and take AP exams. Students who were more fully engaged in the program exhibited more confidence in their abilities.



### Participation is critical for program success

A large majority of schools achieved a high degree of fidelity (at least 80%) in implementing the program across the threeyear grant period, although not all elements of the program were implemented with fidelity. In addition, the longer schools implemented the program, the greater its effects were.

To learn more about each of these findings, read on.



### THE COLLEGE READINESS PROGRAM HELPED TRANSFORM THE CULTURE AT PARTICIPATING **SCHOOLS**

CRP is designed to push school cultures toward greater inclusion, higher expectations and more emphasis on STEM education for all students - and the program's evaluation found that this shift did, indeed, occur. The change in culture was more pronounced in schools that offered few or no AP courses before engaging with NMSI.

In interviews conducted during the program's second year (2017-18), 64% of teachers and 77% of administrators felt CRP had a positive impact on their school's culture. Teachers who were in their second year of the program at that point were more likely to observe a shift in culture than those who were still in their first year of implementation:





In surveys of teachers during the third year of the program (2018-19), 78% agreed that their school's administration "promotes a culture of continuous improvement" and 79% agreed that it "values STEM learning."

A smaller majority of teachers believed their school set clear goals for either AP enrollment or exam performance, which might indicate an opportunity for clearer messaging and goal setting in the future.





Perhaps because teachers felt strongly that their schools considered all students capable of achieving at high levels and encouraged all students to enroll in AP exams, they did not believe to a very strong extent that many students for whom AP was a good fit were being left behind:







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A significant majority of teachers and administrators felt their school culture had changed in a positive way as a result of implementing the program.

CRP teachers believed their school's administration 2 promoted a culture of continuous improvement and placed a high value on STEM learning.

CRP teachers strongly believed their school considers all students capable of achieving at high levels, and most did not think that students who might do well in AP classes weren't enrolling.



## CRP LED TO INCREASED PARTICIPATION IN AP COURSES AND EXAMS

A primary goal of CRP is to increase enrollment in AP courses, particularly for students who might not typically see than at the CRP schools. This might themselves as "AP students," and that's exactly what occurred. Participating schools saw higher levels of student enrollment in AP courses, thus exposing more students to college-level work.

The CRP schools also experienced a higher number of AP exams taken as a percentage of total school population. In 2018, the probability of a student taking an AP exam in the program schools was, on average, 7% higher than the paired comparison schools, and the difference was statistically significant. In 2019, the difference was even greater. as the probability of taking an AP exam was much higher in program schools (18%) than in the comparison schools (3%).

There was a higher percentage of qualifying scores, which measure how gualified a student is to receive college

credit and placement, on the AP exams taken at the control schools be because not all students in those schools were required to take the AP exam (unlike at the CRP schools. where taking the AP exam was a requirement for students enrolled in AP courses). This could result in only the top students actually taking the test in the control schools, artificially inflating the results. Access to AP courses is also gated in many schools. which could create a similar impact.

However, even CRP students who didn't achieve a gualifying score on the AP exam derived significant benefits from taking an AP course. Engaging traditionally underserved students in rigorous, college-level learning while they're in high school can help them see themselves as worthy of college, thus increasing their aspirations of a postsecondary education.







Teacher surveys confirmed that the program was successful in increasing opportunities for all students especially previously underserved students - to achieve at high levels. In fact, 83% of teachers said they believe CRP is an effective way to increase student enrollment in AP courses.

While some teacher comments focused on the classroom challenges of allowing all students to enroll in AP courses, such as "all you are doing is watering down AP courses," an overwhelming majority of teachers

(81%) said opening enrollment to all students had a positive impact on AP programs. Thirty percent of teachers said CRP contributed to a major improvement in recruitment of high-need and traditionally underrepresented students into AP courses, and 51% felt it contributed to at least a slight improvement in this area.

The schools' lead program implementation administrators, were even more positive about the impact of expanding AP enrollment to students not traditionally identified as "AP Students." All but one of those administrators (32 out of 33) said open AP enrollment had a positive impact on the AP program at their school and that CRP was an effective way to increase student enrollment in AP courses. Forty-two percent agreed that CRP contributed to a major improvement in the recruitment of high-need and traditionally underrepresented students into AP courses, and 58% believed the program made at least a slight improvement in this area.





Participating schools saw higher levels of student enrollment in AP courses, thus exposing more students to college-level work.

The probability of students taking an AP exam was significantly higher in the program schools than in the comparison schools.

Surveys confirmed that the program was an effective way to boost opportunities for all students to achieve at high levels through AP coursework, especially students who were previously underserved.



## **TEACHERS' SKILLS IN TEACHING RIGOROUS STEM CONTENT INCREASED**

Decades of research confirms that highly skilled teachers have significant impacts on student success. With this idea in mind, one CRP goals is to increase educators' capacity to effectively teach rigorous STEM courses. More than half of the program teachers said they gained content knowledge and instructional skills.

Surveys asked teachers to indicate how much CRP improved their content knowledge, instructional skills, techniques and strategies. More than half of the respondents (56%) said CRP contributed to a "major" improvement in their content knowledge. (When asked to rate their improvement on a 3-point scale, with 1 being "no improvement," 2 being "slight improvement," and 3 being "major improvement," the average rating that teachers gave was 2.50.) Similarly, 60% of the CRP teachers indicated improvement in their instructional skills and strategies, with an average improvement rating of 2.54 on a 3-point scale.

Students who participated in CRP overwhelmingly agreed their AP teachers "understand the content they are teaching." This statement averaged a 3.78 on a four-point scale of agreement, with 1 being "strongly disagree" and 4 being "strongly agree."





Administrators, too, noticed a difference in their teachers' skill levels. When administrators were asked to indicate the extent to which CRP contributed to improvements in certain areas, the highest level of perceived improvement was in teachers' instructional skills, techniques and strategies (2.73 on a 3-point scale), followed by teachers' content knowledge (2.61). Seventy-three percent of respondents thought CRP contributed to a major improvement in teachers' instructional skills, and 61% indicated major improvement in teachers' content knowledge.

The 61 teachers who completed the survey in each of the three-year evaluation period felt more strongly after the third year that they had a good understanding of the concepts in their field when compared to the first year of the program.







- A majority of teachers believed CRP contributed to a "major" improvement in their content knowledge and instructional skills and strategies.
- Administrators echoed these sentiments: 73% Z said the program made a major improvement in teachers' instructional skills, and 61% indicated major improvement in their content knowledge.
  - Students overwhelmingly agreed that their AP teachers "understand the content they are teaching."



## STUDENTS BECAME MORE CONFIDENT IN THEIR OWN ABILITIES

Self-confidence plays a major role in whether students pursue STEM courses and career pathways. As researchers have noted, cultural stereotypes have reinforced the perception among many students that math and science are difficult subjects that are only accessible to those with superior intelligence-and these perceptions have contributed to low enrollment and high attrition rates in STEM-related college programs.<sup>3</sup>

One CRP's goal is to counter this perception and instill confidence

among students that they can thrive in rigorous STEM courses—and the program succeeds in this area, as well. In fact, CRP students expressed a high degree of confidence in their ability to complete AP courses successfully (3.33 on a 4-point scale), learn new STEM content (3.26), and successfully take AP exams (3.09).

Furthermore, students who were more fully engaged in the program exhibited a higher degree of confidence in their abilities. One of the program's components is a series of after-hours

study sessions for students to extend their learning. Students who attended more study sessions were more likely to express confidence in their abilities.

Eighty-seven percent of students surveyed in 2018-19 planned to attend at least a four-year college or university, which may indicate that among CRP participants, increased confidence led them to pursue college careers.









Students who participated in the CRP expressed a high degree of confidence in their ability to complete AP courses, learn STEM content, and take AP exams.

2 Students who were more fully engaged in the program exhibited more confidence in their abilities.



## PARTICIPATION IS CRITICAL FOR PROGRAM SUCCESS

While not all elements of the program were implemented with fidelity, a high degree of fidelity was reached in a large majority of CRP schools across the three-year grant period. During the 2017-18 school year, for instance, 43 of the 48 participating schools (89.6%) achieved a fidelity score of 80% or better—and four schools achieved a 100% fidelity score. Numerous findings from the evaluation process suggest that schools realize greater impact the longer or more faithfully they execute the program. Since CRP is designed for selfsustainment, schools can successfully run the program long-term without direct intervention from NMSI.

For example, the estimated probability of a student taking an AP exam was 13% at the schools where the program had been implemented for one year, compared with 23% at schools where CRP had been in place for two years. Three out of four teachers (75%) felt more qualified to teach AP courses after their second year of training, compared with 64% of teachers in the first year of the program. And teachers agreed with the following statements more definitively in the third year of the program than they did in year 2:





### After-hours instruction and review

A major CRP component provides students with 12 hours of instruction outside their normal classroom experience. Each supported AP course included three, four-hour blocks of weekend instruction taught by master AP teachers, which equates to three extra weeks of AP class time. These student study sessions exposed students to different teaching perspectives and methods. They also provided professional development and collaboration opportunities for teachers, who were able to connect with peers from the region and see how expert teachers addressed difficult parts of AP courses.

Students were expected to attend three Saturday morning student study sessions for each AP course in which they were enrolled. Teacher participants commended these sessions as an important CRP component. AP courses cover a lot of content, and the study sessions were seen as helpful for giving students additional instructional time. About 80% of students found the study sessions to be extremely or somewhat useful. The higher the percentage of study sessions attended, the more useful students found them.

The Saturday study sessions proved useful for teachers, as well. When asked to rate the extent of their agreement on a 4-point scale, teachers largely agreed with the statements. "The study sessions highlighted the instructional needs of the students so I could continue to address them in class" (3.22 out of four); "I was able to take the strategies employed during the study sessions back to the classroom to help improve student achievement" (3.07): and "I learned a great deal from watching the expert teachers" (2.95). More than two thirds of teachers (68%) indicated that the student study sessions were useful or extremely useful.

Saturday instruction provides many logistical challenges, and not all students managed to attend all three study sessions. As one survey respondent noted, "Our students are burned out by the time Saturday comes from working hard during the week. Also, several students are involved in other things on Saturdays."

Participating schools used creative methods to incentivize and facilitate attendance, such as offering extra credit or providing students with transit passes. "We provide comp days to students who attend, meaning they can miss up to two class periods in a given class after the AP exam for every study session they attend in that subject area," one respondent noted. Another said: "If students attended all three [sessions], I personally provided tickets to [a local] amusement park."





A large majority of schools reached a high degree of fidelity in implementing the program—and the longer schools had the program in place, the more impact it had.

The probability of a student taking an AP exam was 13% in schools where the program had been in place for one year and 23% at schools in their second year.

75% of teachers felt more qualified to teach AP courses after their second year of training, compared with 64% of teachers in their first year.



### BEST PRACTICES FOR SUCCESS

The CRP evaluation revealed a lot about which supports were most effective in helping the program achieve its goals. Based on the evaluation results, here are two key practices that proved to be particularly effective in helping more students master rigorous AP coursework in the participating schools—practices that other schools can learn from.

### **Intensive Teacher Training**

CRP supports high-quality instruction by providing off-site training, mentoring and instructional resources for teachers. Teacher participants repeatedly cited the program's intensive professional development component as its most useful support structure, and it helped drive higher student achievement.

The training began with a four-day summer session that was reinforced with three additional days of training throughout the school year. AP teachers also have access to an expert mentor to provide coaching and support during the school year, including (but not limited to) guidance on pacing, common challenges and locating additional instructional resources.

From a list of the many CRP elements, 54% of teachers chose training as the most effective program component. Teachers felt that the four-day summer institute was especially beneficial. Administrators also most frequently named teacher training as the program's most effective component.

A large majority of teachers (85%) were satisfied with the level of training and support they received throughout the 2017-18 school year, and 97% said they felt "adequately prepared" to teach their AP course. NMSI accelerated online training in response to the COVID-19 pandemic, and now offers online, blended or in-person training based on local preferences and health considerations.





#### BEST PRACTICES FOR SUCCESS



### **Incentives for Teachers and Students**

CRP also offered financial recognition to participating teachers, through a stipend and awards tied to achieving goals, as well as monetary incentives for students.

Teachers in NMSI-supported AP courses received an award of \$100 for each AP exam score of 3 or higher (on a 5-point scale) earned by their students. Students also received \$100 for each AP qualifying score they earned in NMSI-supported courses, as well as stipends to cover the exam registration fees. Although these financial supports weren't a critical factor, both teachers and students indicated that they played a role in the program's success.

More than half (52%) of teachers said the incentives were at least somewhat important in encouraging them to teach AP courses. While teachers consistently said the incentives were not the deciding factor, many described them as partial compensation for the additional hours of work involved in the program—particularly the out-of-school training and student study sessions. Several teachers reported that they would be teaching AP courses regardless of the incentives. They also indicated that the incentives were nice to have and a welcome added bonus for their participation.

Only 16% of teachers believed that student financial incentives were among the most important program components. Yet, teachers did view them as a valuable component to encouraging student enrollment in AP courses. "Our students appreciated the stipends for the assessment," one participant said. Students largely agreed, with more than half of students rating the incentives as either extremely or somewhat important in encouraging their participation in AP courses.



#### BEST PRACTICES FOR SUCCESS

### Leveling the Playing Field

Ensuring that all students have opportunities to experience rigorous STEM learning can be challenging, but NMSI's College Readiness Program offers an effective roadmap for achieving this goal.

By providing extensive supports for their schools, teachers and students, such as training, after-hours instruction and financial incentives, school districts can help level the playing field for students of all backgrounds by engaging them in high-quality STEM education and promoting college readiness.

#### To learn more about NMSI and how we support rigorous STEM learning for all students, visit the CRP page on our website.

Let's Connect!

<sup>1</sup>ACT. (2016). The condition of college & career readiness 2016. Retrieved from http://www.act. org/content/dam/act/unsecured/documents/ CCCR National 2016.pdf

<sup>2</sup> For the complete findings, see: CRESST. (2021). 2017-2019 Implementation Evaluation of the National Math and Science Initiative's College Readiness Program. Los Angeles, CA: University of California, Los Angeles. [link]

<sup>3</sup> Sithole et al. (2017). Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges. Higher Education Studies, 7(1). Retrieved from https:// files.eric.ed.gov/fulltext/EJ1126801.pdf

