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RESPONSE TO PRIORITIES

Absolute Priority 1: Supporting Effective Teachers

The National Math and Science Initiative’s (NMSI) proposal, DRIVE CRP Project, meets Absolute Priority 1: Supporting Effective Teachers by improving teacher effectiveness in AP® courses through its innovative and effective College Readiness Program (CRP). CRP increases academic intensity, increases access to rigorous courses, and improves student achievement, especially among traditionally underrepresented and high-need students, by increasing teacher effectiveness in both curricular and pedagogical domains. The most important factor that differentiates the CRP model is its ability to demonstrate an increase in teacher effectiveness by measuring student outcomes on a rigorous metric. CRP increases the number of students taking and earning qualifying scores (3 or above on a 5-point scale) in Advanced Placement® (AP®) courses and exams in math, science, and English. NMSI makes a dramatic difference in student achievement (and therefore teacher effectiveness) in only one year and transforms school culture over three years. Based on AP® data from the College Board, the increase in qualifying scores after just one year of CRP implementation in six cohorts of NMSI partner schools (2009–2014) was 68% compared with the average national increase of 6.8% over the same time. CRP’s lasting impact on teachers and students is discussed in more detail in the Significance section of this application.

The National Math and Science Initiative’s (NMSI) SEED grant proposal meets the Moderate Evidence of Promise threshold. CRP has been studied across a number of settings, and a growing body of evidence indicates that CRP not only increases the effectiveness of teachers as measured by increasing the probability that students will take and earn qualifying scores on AP exams, hence increasing their achievement and college readiness, but also has significant and longer-
term positive postsecondary and economic impacts. The program’s consistent elements produce reliably successful and sustained outcomes across settings, states, subject areas, teachers, and students, including in schools with students traditionally underrepresented in AP courses. The four studies referenced in our Evidence Form (attached) represent an array of well-designed, well-implemented research studies that present solid evidence of the effectiveness of CRP, from impact on immediate outcomes related to AP, to postsecondary results, to longer-term lifelong impacts. Individually, we propose that each study meets the What Works Clearinghouse (WWC) standards with reservations. As a collective group, we purport that CRP is supported by the moderate evidence-driven practices required for the proposed SEED grant.

**Competitive Preference Priority 1: Promoting Diversity in the Educator Workforce**

Research presented by Frederick Hess and David Leal (1997) indicates that the percentage of non-white faculty has a significant positive relationship with overall college matriculation rates in urban school districts across the nation. However, nationwide, the teacher workforce does not reflect the diversity of students. For example, the 2013 National Center for Education Statistics Condition of Education report shows that the percentage of teachers across the nation shows an overrepresentation of White teachers (82%), when compared to 7% of African-American teachers and 8% of Hispanic teachers.¹ Both Clayton and DeKalb County Public Schools have recruited a teacher workforce that is largely reflective of the student population, with the exception that white teachers are overrepresented in both districts (Table 1).

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Table 1. Percentage of Teacher and Student Demographics by District

<table>
<thead>
<tr>
<th></th>
<th>Asian</th>
<th>Hispanic</th>
<th>Black</th>
<th>White</th>
<th>Other</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>T</td>
<td>S</td>
<td>T</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Clayton County</td>
<td>2.6</td>
<td>4.3</td>
<td>3.3</td>
<td>16.4</td>
<td>74.2</td>
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<tr>
<td>Public Schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DeKalb County</td>
<td>2.0</td>
<td>5.6</td>
<td>3.4</td>
<td>11.3</td>
<td>67.1</td>
</tr>
<tr>
<td>Public Schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T = Teachers, S = Students

While the districts’ demographics are promising, the stability of teachers, particularly after schools invest in further development for these teachers, is also paramount. This may be even more significant for AP teachers which, in combination with any training teachers may receive about race relations and teaching children of poverty combined with their content knowledge / course-specific training, means that these teachers may be more difficult to replace. Georgia’s statewide teacher evaluation system (Teacher Keys Effectiveness System) prioritizes teacher professional development and performance standards, plus student growth measures as depicted in Figure 1.2

The teacher supports provided in the DRIVE CRP Project directly address a majority of GA’s defined performance

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standards (see Figure 2), specifically around the planning, instructional delivery, and assessment of and for learning domains. CRP has been documented to dramatically increase student achievement in one year, thus addressing the student growth component of TKES. Therefore, DRIVE CRP Project can contribute to teacher retention by providing support for AP teachers on the statewide evaluation. Since both participating districts have a diverse educator workforce, the retention of this diverse educator workforce is meets CPP1: Promoting Diversity in the Educator Workforce.

Competitive Preference Priority 2: Support for Personalized Learning Environments

3 Stronge, James, page 8.
The **DRIVE CRP Project** meets **CPP2: Support for Personalized Learning Environments** by providing teachers with training, systems, and curricular materials to individualize learning for all students. CRP teachers have access to two key online curricular resources:

**The NMSI teacher portal:** Each subject has a separate section for teachers with details regarding successful implementation of AP programs, targeted toward the most important information for increased achievement on AP exams.

**The Quest homework system:** An extensive knowledge bank of more than 60,000 questions and answers covering math, biology, chemistry, computer science, and physics that provides a user-friendly, formative assessment system that allows teachers to customize their instruction and homework assignments toward a student’s individual learning needs.

Additionally, there are **specific student supports that directly facilitate personalized learning through NMSI’s Learning Management System (LMS).** Activities are designed to increase the content- and skill-based knowledge of the students as well as provide additional time-on-task, preparing them not only for the AP exam, but also for the demands and expectations of college-level work. Students experience the content review and/or skill-based lessons in four, increasingly complex, components. (1) Students begin by experiencing the modeled activity within their own classroom, which the teacher facilitates. (2) Students, through asynchronous learning blocks within the LMS, facilitate their own learning by seeing relevant examples of the content/skill in their everyday lives, gaining practice through asynchronous activities, and assessing their knowledge at the end of the module, providing direct insight to whether the student has or has not mastered the concept and/or skill. Student can repeat the learning block as many times as it takes to obtain mastery. (3) Students participate in a monthly structured tutorial led by a NMSI expert, held as a synchronous session through NMSI’s LMS.
During these synchronous sessions, students can see additional examples of the concept and/or skills and can ask clarifying questions. (4) Students participate in a student forum within the LMS, in which they can ask remaining questions regarding the concepts, skills, and/or AP exam strategies. The forum is facilitated asynchronously and will enable the teacher, consultant, and other students to weigh in on solutions, best strategies, and offer examples. This forum will also inform the consultant on what activities (e.g., lessons, free responses, and/or essays) would be appropriate for subsequent months’ student activities.

INTRODUCTION

The National Math and Science Initiative (NMSI), a national 501(c)(3) nonprofit organization, is applying for a SEED grant, Deepening Resources for Instruction by Valuable Educators (DRIVE) College Readiness Program (CRP) Project, to improve teacher effectiveness (as measured by qualifying score earning rates on AP tests) in 20 participating high schools across two of the largest districts in Georgia, DeKalb County Public Schools (DKCPS) and Clayton County Public Schools (CCPS). NMSI was formed to address one of this nation’s greatest economic and intellectual threats—the declining number of students who are prepared to take rigorous college courses in math and science and are equipped for careers in those fields. NMSI’s CRP is raising the academic bar in public schools by demonstrating that more students, especially high-need students, can master rigorous Advanced Placement (AP) coursework.

CRP partners with schools to improve teacher effectiveness in AP courses, therefore increasing the number of students taking and earning qualifying scores on AP math, science, and English exams. There are three critical elements of CRP’s success: teacher support, student support, and school support (see Quality of Project Design for more detail). This SEED proposal focuses on further improving the teacher supports provided within CRP.
Rigorous research confirms strong evidence of effectiveness at the national level for CRP. Specifically in Georgia, Grovetown High School became part of NMSI’s College Readiness Program in 2014. Through a partnership with the Department of Defense Education Agency, NMSI was able to bring CRP to Grovetown High School with tremendous success. Every teacher at Grovetown HS met their individual goal for number of qualifying AP® scores for the year, resulting in 206 qualifying scores across the high school.\(^4\) This represents an overall 142 percent increase in qualifying scores from the year prior to CRP implementation.

Expected outcomes from the DRIVE CRP Project include: 1) student enrollment in AP courses, particularly among traditionally underrepresented populations, will increase from the baseline year by at least 80% for each LEA partner in the first year and 140% over three years; and 2) Students’ qualifying scores in program schools in AP math, science, and English will increase by at least 70% for each LEA after the first year of CRP, and at least 125% over the three-year grant period.

(a) Quality of Project Design

(1) Exceptional approach

The objective of CRP is to dramatically increase the number of students taking and earning qualifying scores on AP math, science, and English exams. The CRP logic model (see Figure 3) identifies the key factors of CRP that are necessary ingredients for success across students, teachers, and schools.

Within the logic model for CRP, NMSI has identified the key factors that are indispensable

\(^4\) The NMSI AP goal is 181 qualifying scores, therefore Grovetown HS exceeded their schoolwide goal.
to expanding the program with fidelity. These Elements of Success (see Figure 4) are the foundation for a successful CRP, and, as such, NMSI requires strict adherence to each.

**Teacher support**: CRP’s teacher support is defined as **preparation**, **professional development**, and **ongoing support**. CRP teachers also have access to **online curricular resources** that help facilitate students’ personalized learning (CPP2).

**FIGURE 3. NMSI’s College Readiness Program (CRP) Logic Model**

**Student support**: CRP provides support for students through **study sessions**, provision of classroom equipment and supplies, as well as **AP exam fee subsidies**.

**School support**: CRP provides the following school supports: **Performance Analysis**: Annual review of program components and compliance to ensure maximum program effectiveness.
**Academic and Program Experts:** Detailed curricular, programmatic, and logistical support provided by experienced academic content directors and program managers.  

**Shared Goal Setting / Accountability:** Mutually agreed upon expectations for program directors and program managers, as well as goals for teachers, students, and schools.

NMSI assigns a Program Manager to each participating school. Regular communication typically flows through the Designated Administrator at each school, via email, phone, and video-conference. Additionally, there are occasional in-person visits at key moments of time in the school cycle.

**Financial awards:** Offering financial awards sends a message to students and teachers alike that success in rigorous courses and extra studying and teaching time are valued. Research shows that students who participated in CRP in high school went on to attend college in greater numbers and had improved college GPAs.\(^5\) Concerns that awards-based interventions may lead to “teaching to the test” and cheating were not realized, while the benefits of CRP awards that induce students to reach for higher standards lasted in post-secondary education.

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\(^5\) Jackson 2014.
Deeper Curriculum Development

CRP teachers seek more robust resources to facilitate rigorous learning experiences which lead to high levels of student achievement in AP courses. Currently, a dearth of quality AP curricular resources exist, and NMSI is well positioned to be a provider of rigorous AP curricula. Our first target courses are: AP Biology, AP Environmental Science, AP Physics 1, AP Statistics, and AP English Language. We are prioritizing these courses first because we believe they could have a large impact on growth in student achievement and teacher development because of the intersection of high enrollment\(^6\) and current scores on AP examinations.\(^7\)

We believe curriculum can serve the purpose both of providing students with powerful and rigorous learning experiences, and developing teachers’ instructional repertoire and capacity for curriculum adaptation and development. We utilize the *Educative Curricular Resources*\(^8\) framework, which provides teachers with tools to integrate their ideas about core concepts and principles, instructional representations, and typical student ideas. These curricula will be more of a library of resources and less a scripted set of exercises. They will rely on the teacher’s agency, planning, and adaptation to meet the needs of his/her students. In addition to being a vehicle for powerful student and teacher learning, we wish for NMSI curricula to embody principles of cultural responsiveness, be connected to students’ daily lives, and scaffolding which will provide the means for narrowing achievement and skill gaps.

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\(^6\) These five courses comprise 63.5% of the total enrollment in AP courses in NMSI’s CRP schools, based on 2016-17 data.

\(^7\) There is large room for growth in both passing scores and moving more students beyond scores of 1.

(2) Training of quality, intensity, and duration to lead to improvements

CRP is a proven model of teacher support, focusing on preparation, professional development, and ongoing support. NMSI offers aligned, rigorous training coupled with on-the-job mentoring. Specifically, NMSI hosts a four-day AP Summer Institute, a two-day training in the fall, and a spring training and mock exam reading. Additional elements of support include mentoring, via NMSI’s Learning Management System, to provide curricular help, pacing guidance, and instructional feedback. Specifics of these training components are detailed below.

- All AP and pre-AP teachers will travel to a physical site for a four-day Summer Institute designed to orient them to the frameworks and expectations of their specific AP course and AP Examination. Teachers receive instruction and guidance for delivering rigorous AP content to diverse student populations and well as curricular supports and model instructional units. Teachers will be trained on NMSI’s learning management system (LMS), which will serve as the online platform for the cohort’s virtual interactions and resource library. The CRP Summer Institute allows teachers to engage deeply with AP and NMSI curricula and instructional practices, and build meaningful connections with their cohort peers.

- After the Summer Institute, subsequent interactions between teachers and NMSI representatives will happen virtually—both in monthly cohort groups and in one-to-one settings—using the LMS’s web conferencing and collaboration tools. The training curriculum will follow a progression model, designed to move teachers through an examination of educative curricular resources, to implementation of these model lessons and resources in their classrooms, to the development and design of their own curricular materials and the delivery of dynamic classroom practices and strategies. Each cohort will be led by an expert AP teacher/consultant, who will review educative units and implement shared lessons
and tasks in their classrooms. As part of the training curriculum, teachers and cohort leaders will discuss implementation strategies, assessment and feedback practices, and curricular resources. Using tools embedded in NMSI’s LMS, teachers will upload videos of their own teaching and will receive feedback on their classroom practice from cohort leaders as well as peers. In addition, teachers will participate in idea sharing via discussion boards and interest groups and will participate in collaborative writing workshops and unit building exercises.

- Interested teachers may also have access to a Mentor, an expert AP teacher who can offer continuous support in development of the teacher’s core knowledge and skill, conceptual understanding, and knowledge of practice. Mentoring is designed to support the monthly virtual cohort meetings and asynchronous collaborations through real-time and on-demand support and resource sharing. NMSI has been using an online mentoring system for the past several years, and began utilizing the LMS for mentoring in the 2016-17 school year.

(3) Partner collaboration

One of the goals of the DRIVE CRP Project is to build knowledge and capacity in the teachers of participating schools so they can continue to do this work on their own after the grant period. Because a number of factors affect the specific amount and type of sustaining support needed (e.g., total student population, AP course offerings, and teacher turnover), NMSI will work directly with school leaders to determine priority areas that can equip and empower teachers to continue to implement lessons learned beyond the grant period. Additionally, teachers will be a part of shaping the development of our curricula. NMSI will provide extensive support to teachers including providing opportunities for participating teachers’ structured reflection on the unit, supplying classrooms with materials necessary for implementing the units, and providing feedback sessions on the implementation of units.
(4) Services focused on highest needs

Out of 33 High Schools across DeKalb County Public Schools and Clayton County Public Schools, we anticipate approximately 20 will participate in the **DRIVE CRP Project**. The schools will be informed of the opportunity, and then they will have the opportunity to submit a program application. As is standard practice in all of NMSI’s CRP work, all schools that submit an application will be accepted; the application ensures that there’s buy-in at the school level, which is essential for success, especially in the previously described school level supports components of the Elements of Success. Using a consistent selection process helps ensure that teachers and administrators demonstrate the commitment and key mindsets required for the success of CRP. NMSI looks to work with schools that demonstrate the following characteristics:

**Growth mindset:** educators must be committed to the principle that all students can succeed.

**Implementation capacity:** schools must be committed to focusing on the implementation of CRP and have the resources to do so, such as teachers available to expand AP course offerings, the scheduling capability to meet expanded course needs, etc.

**Leadership:** school leaders must be willing to address the barriers preventing schools, teachers, and students from maximizing success in AP performance and to make changes within the schools to leverage the full benefits of the CRP, which often includes amending school policies (related to grading, scheduling, and course admittance).

**Teacher commitment:** Teachers must commit to attend training sessions, implement key program elements into their instruction, and be willing to utilize feedback and new instructional concepts in their classrooms.

During the **DRIVE CRP Project**, we will reach approximately 10,00 high school students directly enrolled in AP and pre-AP courses in 20 high schools, and the 560 teachers that
lead those courses. Additionally, the training and resources provided through this program will build each participating school’s capacity, thus serving teachers and students in the years following the end of the grant period.

(5) Services address the needs of the target population

CRP increases academic intensity, increases access to rigorous courses, and improves student achievement in order to decrease the college readiness gap, especially among traditionally underrepresented and high-need students. For this reason, NMSI prioritized partnering with two Georgia districts that have high populations of traditionally underrepresented and high-need students. Of the 33 high schools across the two participating districts, 85% of the 33 High Schools are Title 1 Schools. 42,187 total high school students across the districts, of which 77% are eligible for FRL and 93% identify as non-white. Specific district demographics are summarized in Table 2.10

Table 2. Student Demographic Data for Participating Districts

<table>
<thead>
<tr>
<th></th>
<th>Asian</th>
<th>Hispanic</th>
<th>Black</th>
<th>White</th>
<th>Other</th>
<th>Free / Reduced Price Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCPS</td>
<td>4.25%</td>
<td>16.38%</td>
<td>74.34%</td>
<td>2.6%</td>
<td>2.43%</td>
<td>96%</td>
</tr>
<tr>
<td>DKCPS</td>
<td>5.59%</td>
<td>11.33%</td>
<td>71.87%</td>
<td>9.55%</td>
<td>1.66%</td>
<td>67%</td>
</tr>
</tbody>
</table>

9 For purposes of this application, the college readiness gap is measured by the number of high-need students who take and earn qualifying scores on AP exams, because the AP exam is one of the few nationally accepted proxies for college readiness

10 https://gaawards.gosa.ga.gov/analytics/K12ReportCard accessed on June 18, 2017
It is estimated that in 2014, only 43% of U.S. high school graduates were ready for college-level math, and only 37% were ready for college-level science.\textsuperscript{11} These problems are even more pronounced for the high-need and traditionally underserved students whom the proposed LEA partners serve in high concentrations; these students face hurdles because of policies and mindsets that limit their ability to access rigorous coursework. Recent National Science Foundation (NSF) data found that more than one-fourth of ninth graders in NSF’s lowest socioeconomic status category were not enrolled in any science courses (27%), compared with 11% of students in the highest income category. These differences in access lead to achievement gaps that persist through college and beyond. The gap between white students’ six-year college graduation rates and their African American peers is 22 percentage points, and the gap between white students and their Hispanic peers is 10 percentage points.\textsuperscript{12} These performance gaps also exist in the two participating districts, as summarized in Table 3.\textsuperscript{13}

### Table 3. AP Test Taking and Qualifying Score Earning Rates for Participating Districts

<table>
<thead>
<tr>
<th>District</th>
<th># of AP Tests Taken</th>
<th>% of AP Tests Passed</th>
<th># of Non-White AP Tests Taken</th>
<th>% of Non-White AP Tests Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCPS</td>
<td>2,337</td>
<td>19%</td>
<td>1,820</td>
<td>17%</td>
</tr>
<tr>
<td>DKCPS</td>
<td>8,054</td>
<td>44%</td>
<td>4,169</td>
<td>24%</td>
</tr>
</tbody>
</table>

(b) Significance

(1) Outcomes improve student achievement

NMSI’s Proven Track Record

\textsuperscript{11} ACT, Inc. 2014.

\textsuperscript{12} Kena, G., et al. 2014. See Table 326.10: Graduation rate from first institution attended for first-time, full-time bachelor’s degree-seeking students at 4-year postsecondary institutions.

\textsuperscript{13} [https://nces.ed.gov/ccd/elsi/tableGenerator.aspx](https://nces.ed.gov/ccd/elsi/tableGenerator.aspx) accessed on June 13, 2017
A growing body of evidence indicates that CRP not only increases the probability that students will take and earn qualifying scores on AP exams, hence increasing their achievement and college readiness, but also has significant and longer-term positive postsecondary and economic impacts. The program’s consistent elements produce reliably successful and sustained outcomes across settings, states, subject areas, and students. Across studies, research questions consistently relate to the extent to which implementation of CRP is associated with increased percentages of high school students taking AP exams and increased percentages of students scoring 3 or higher on these exams.

Holtzman (2010) found that in its first year, CRP had a positive and statistically significant impact on student enrollment in AP courses in math, science, and English and on students’ success on related AP exams, as measured by exam scores of 3 or higher. Using a comparative interrupted time series (CITS) design, Holtzman matched 64 program schools with 128 other equivalent schools within their states, without any statistical adjustments, on pre-treatment values for each of the three pre-implementation years and were also equivalent in enrollment, percentage urban, and percentage rural. Selecting two comparison schools per program school, the nearest above and nearest below neighbors on a composite value, enhanced power for the analysis and the balance between the comparison and program schools on the pre-implementation outcomes. Fixed-effects regressions showed that in all five of the subject areas/combinations, implementation of CRP was associated with large and statistically significant increases in the percentages of students taking AP exams. Notably, program implementation was associated with a 12-point increase in the percentage of students taking at least one math, science, or English AP exam — growth of more than a full standard deviation.

In addition, CRP implementation was associated with strongly significant increases in the
percentages of students earning qualifying scores, with effect sizes up to 0.5. Although the effects on exam-taking clearly indicated that more students attempted AP exams in program schools than in non-program schools, it is also true that more students earned qualifying scores. This suggests the possibility that while CRP expands access to AP opportunities, it also supports an expanded pool of students who succeed.

Jackson’s first two studies (2007, 2010), both quasi-experimental in nature, used a differences-in differences (DID) regression approach with matched comparison schools that wanted to implement the program. Both examined the impact of the early Texas program (now known as CRP), extending the research beyond K-12 outcomes into the longer-term rationale for the program: success in the postsecondary years. The earlier study, deemed consistent with WWC evidence standards with reservations in 2008, found positive effects on AP course enrollment, SAT/ACT scores, and college matriculation for students in participating schools (Jackson, 2007). The latter also identified longer-term outcomes of the program, reporting positive effects on college matriculation, college GPAs, and college persistence (Jackson, 2010).

Jackson’s 2014 work extends these outcomes by investigating not only the long-run educational effects of CRP, but also enduring labor-market outcomes, such as wages. It shows not only that CRP works, but also that it contributes to the desired end. Again using a quasi-experimental DID strategy, Jackson compares the change in outcomes between observationally similar students from the same high school before and after CRP adoption to the change in outcomes across cohorts from other high schools that did not adopt CRP over the same time period. Jackson’s findings are derived from a sizable sample of students within schools that adopted the program (58 schools representing 137,704 students) and schools that did not adopt
the program (1,413 schools representing 156,858 students). Through the study’s design, access to extensive longitudinal data across multiple sectors, and use of a series of empirical tests, Jackson both builds a compelling case for the impact of CRP and successfully addresses a range of potential threats to validity. **Short-run AP outcomes, examined over four years, were significant, showing the program’s positive effect on AP exams taken and qualifying scores earned** (both \( p=.01 \)). **Postsecondary outcomes were also significant**, with the program’s effect being positively related to retention in college (e.g., “ever being a freshman”, “ever being a sophomore”; both \( p=.01 \)) and freshman year grade point average (\( p=.05 \)). Jackson also reported a **positive CRP effect on earnings, with an overall 2.7% increase that was largest and statistically significant** (\( p=.05 \)) for the second post-adoption cohort (3.8% increase in earnings).

Brown and Choi’s approach (2015) employs a potential outcomes modeling approach (Rubin 2005) to estimate the causal effect of CRP program participation on first-, second-, and third-year improvements over base year in AP exam taking and AP qualifying score earning in math and science AP subjects. In addition to showing the impact of the program on the desired outcomes, it also **shows the manner in which the impact happens**. Using a propensity weighting approach (Rubin 2005), Brown and Choi accessed data from 287 treatment schools and 10,097 non-treatment schools.

**Sherman and Song (2014, 2015), as part of their current i3 evaluation of CRP in two states, provide longer-term evidence of CRP success, showing positive impacts on students’ AP performance based on multiple years of program implementation across two cohorts of schools in Colorado and Indiana.** Again using a CITS design, changes in average AP outcomes over time of high schools implementing CRP (\( N=18 \)) were compared with the changes in
matched comparison schools that were not implementing the program (N=18). The authors utilized a two-level hierarchical linear model (HLM) nesting four student cohorts within each school and controlling for school background characteristics. First-year outcomes in this study again show that CRP schools significantly outperformed the comparison group schools both in the percentage of students taking an AP exam in math, science, and/or English and in the percentage of students earning qualifying exam scores in these subjects. In the second year, using the same cohort of schools, the study found that treatment schools significantly outperformed comparison schools in the percentage of students taking AP exams and the percentage earning qualifying scores across all subject areas and all analyses. For example, the percentage of students who took an AP exam in math, science, or English increased by 7.80 percentage points for the treatment schools, but decreased by 2.29 percentage points for the comparison schools over the same time period (significant difference of 10.09 percentage points; p < 0.001). Similarly, the percentage of students earning qualifying scores on AP exams in math, science, or English increased by 3.28 percentage points, but decreased by .48 percentage points for the comparison schools over the same time period (significant difference of 3.76 percentage points; p < 0.001). In addition, significant first-year effects for AP exam taking and qualifying score earning were found for female students and minority students when analyzed separately.

The average effect size (Cohen’s d) for first-year increases over both average treatment on treated and average treatment effects for all students, all subgroups of students, both outcomes, and all disciplines was 0.64, showing a substantial positive causal impact. These first-year effects persisted into the second year (average effect size of 0.64) but diminished slightly in the third year (average effect size of 0.59). The effects are stronger when looking only at the average treatment on the treated effects, where the average effect size for first-year effects was 0.69. This
increased to 0.73 for average second-year effects and returned to 0.68 for average third-year effects. Data collected from over four years as part of this study of the program in Colorado and Indiana demonstrate consistency with findings of the three-year, two-year and one-year impacts for the original cohort of schools. In the fourth year when grant support was discontinued at the treatment schools, they continued to significantly outperform the comparison schools in all of the AP outcomes examined. These findings indicate that the significant and positive impact that CRP program had on the percentage of students passing AP exam in the Cohort 1 schools during the implementation years was sustained a year after the program implementation ended.

Taken together, the results of the Holtzman, Sherman and Song, Jackson, and Brown and Choi studies suggest that participation in CRP is expected to have significant effects for students that will positively impact their achievement, college readiness, persistent enrollment, and potentially their lifetime earnings. Therefore, studying CRP’s impact on teacher effectiveness will likely add to the body of research knowledge about AP education.

Curricular Supports

In addition to a dearth of AP material, within the AP community there exists a legacy culture of “curricular agnosticism”. This view originated with a genuine interest in the capacity. NMSI has some curricular supports, though they are inconsistent and in need of development to become robust educative curricular supports. NMSI is well positioned to be a national leader in the production and/or provision of rigorous AP curricula. We wish to combine our future efforts to provide robust curricular supports with our historical commitment to teacher development to promote both teacher and student learning. Specific features of educative materials include: content, disciplinary, literacy, narrative, and assessment, which can support teachers’:
• Capacity for anticipating and interpreting what learners may think about or do in response to instructional activities

• Learning of subject matter

• Capacity to imagine ways to relate units during the year

• Ability to integrate their knowledge base and make connections between theory and practice.

**Curriculum Design Framework**

Understanding by Design (UbD) is a curriculum-planning framework that grew out of research in cognitive psychology and neurology. UbD “focused on helping students come to an understanding of important ideas and transfer their learning to new situations” by 1) developing and deepening student understanding and 2) creating effective curriculum backward maps. We believe that this framework will provide a useful standardizing structure for the curriculum development team. Furthermore, we believe it will lead to increased preparedness for college through deep understanding of the complex big ideas as detailed in AP frameworks.

*(2) Reasonable costs*

The **DRIVE CRP Project**’s costs are reasonable, yet adequate to drive meaningful improvement in the effectiveness of 560 teachers as measured by increases in approximately 10,000 students’ qualifying scores on exams. The total project budget of $8,168,951 represents an investment of less than $15,000 per teacher and a little over $800 per student. When the non-federal match is considered, the investment of federal funds drops per unit to $11,250 per teacher and $610 per student respectively. When compared with previously funded SEEP grants, these

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14 Wiggins & McTighe, 2011, p. 3.
costs per unit are promising when considering both impact on the sector and return on investment.

(3) **Ongoing benefits to the National Math and Science Initiative (NMSI)**

In 2011 and 2015, NMSI won i3 validation and scale-up grants (respectively), enabling replication of CRP in a total of ten regional hubs across the two grants. The goal of NMSI’s regional hub strategy is to establish a CRP presence within a target geography serving schools within one or more LEA. By establishing a foothold in these metropolitan areas, we grew NMSI’s footprint and diversified its partnership base. Regional hubs also demonstrate to other potential expansion regions what is possible through CRP. The **DRIVE CRP Project** further expands the Atlanta regional hub given the close proximity of Clayton and DeKalb Counties to the city.

(4) **Dissemination of results**

The **DRIVE CRP Project** has practical implications for increasing the effectiveness of high school teachers in rigorous courses. The results of this work will be observed by a variety of Georgia-based higher education partners, including the University of West Georgia, Columbus State University, and Kennesaw State University. These university partners are interested in the increasing teacher effectiveness in rigorous, high school coursework across Georgia and the country. Communication of these outcomes to teacher effectiveness and education stakeholders and policymakers throughout the nation will serve to scale the adoption of a supported AP program to schools nationally.

At the conclusion of the grant period, project results from the evaluation will be disseminated through both the NMSI and the West Coast Analystics (WCA) websites, regular conferences and workshops, and peer-reviewed publications. WCA will formally disseminate the research results
as publications in peer-reviewed substantively oriented journals and methodologically oriented journals. Additionally, WCA anticipates dissemination activities at conferences such as the CCSSO annual conference, and annual meetings of AERA and NCME. NMSI will also create and publish technical reports to be posted on website, which is regularly visited by the thousands of teachers trained annually through our program. Lastly, we anticipate conducting policy briefings with relevant stakeholders at the federal, state, and local levels. A policy brief of our findings, disseminated to a broader audience, will also be shared with those who could champion our work but are not familiar with education research.

(c) Quality of the Management Plan

(1) The extent to which the goals, objectives, and outcomes to be achieved by the proposed project are clearly specified and measurable

Measurable Goals and Outcomes

As shown in the logic model, a number of short- and long-term outcomes will be achieved that will help transform partner LEAs into centers of college readiness.

Magnitude of project impact on students, teachers, and leaders:

• We will reach approximately 10,000 students over the course of the project, including students enrolled in AP and pre-AP courses.

• We will train approximately 560 AP and pre-AP teachers at participating high schools.

Outcomes over the course of the grant. Even over the relatively short time span of three grant years, CRP will have a deep impact on its 20 participating high schools.

• Students’ qualifying scores in program schools in AP math, science, and English will increase by at least 70% for each LEA after the first year of CRP, and at least 125% over the three-year grant period. Measurement: AP qualifying scores, collected annually.
• Teachers will report increased knowledge and use of both content and effective instructional strategies and will implement strategies and techniques learned in NMSI trainings in their classrooms. *Measurement:* Formal and informal surveys, site visits, and NMSI mentor feedback, collected annually.

• Student enrollment in AP courses, particularly among traditionally underrepresented populations, will increase from the baseline year prior to NMSI’s program implementation by at least 80% for each LEA partner in the first year and 140% over three years. *Measurement:* Course enrollment data shared by schools, collected annually.

• Schools will make necessary changes to facilitate expanded access to AP courses and prioritize student success in these courses, including adding AP courses and altering AP sequencing. *Measurement:* Schools’ adding AP courses and altered AP sequencing based on NMSI’s recommendations, and administrator and teacher implementation of programmatic feedback provided by NMSI’s program team, all collected annually.

**Long-term outcomes.** We anticipate that this project will have several important long-term impacts that will continue well after the completion of the SEED grant period, including:

• School culture in partner LEAs will be dramatically altered to encourage and support high academic achievement among all students.

• Program schools will continue to make gains in AP qualifying scores each year, along with an increasing number of AP course enrollments.

• STEM Learning will be fostered and celebrated across partner LEAs.

• Policy makers in LEA partner districts and states will become more aware of the importance of expanding access to AP for all high school students.

• College matriculation and persistence, particularly in postsecondary STEM courses, will
increase for those students who have participated in NMSI’s program.

(2) The adequacy of the management plan to achieve the objectives of the proposed project on time and within budget, including clearly defined responsibilities, timelines, and milestones for accomplishing project tasks

NMSI has overseen $300 million in public-private funds since 2007. The organization has an annual operating budget of $44.7 million in 2017. NMSI has smoothly operated federal grants since 2011 and is therefore familiar with reporting and accountability standards at the federal level, with active grants from the Department of Education, the Department of Defense, and the Office of the Secretary of Defense. Of particular interest when considering this project, NMSI has successfully implemented a 2011 i3 validation grant and is on track on a 2015 i3 scale up grant. For this project, NMSI has developed a robust management plan to ensure it meets its project objectives on time and within budget, consistent with previous success in implementing large-scale grants. The table below summarizes key responsibilities, timelines, and milestones for accomplishing key project tasks; a more detailed CRP implementation timeline is in Other Attachments.

**TABLE 4. Key Activities and Milestones**

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<thead>
<tr>
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<tbody>
<tr>
<td>Solidify communication mechanisms between LEAs, NMSI, and interested schools</td>
<td>EVP/COO President Advancement Team</td>
<td>Planning Year</td>
<td>Project Year 1</td>
<td>Project Year 2</td>
</tr>
<tr>
<td>Manage the application process for interested schools</td>
<td>EVP/COO President CRP Team Advancement Team</td>
<td>Dec</td>
<td>Jan</td>
<td></td>
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<tr>
<td>Task</td>
<td>Responsible Parties</td>
<td>Dates</td>
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<tr>
<td>Finalize participating schools</td>
<td>EVP/COO President CRS WCA CRP Team</td>
<td>March March</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare for implementation:  Evaluate current staffing against grant positions needed; meet with evaluator</td>
<td>EVP/COO CRS WCA</td>
<td>Feb</td>
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<tr>
<td>Confirm data-sharing agreements with College Board and execute contracts with each participating school</td>
<td>EVP/COO CRS WCA</td>
<td>April April</td>
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<tr>
<td>Identify mentors for teachers</td>
<td>CRP Team</td>
<td>May May April</td>
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<tr>
<td>Agree upon annual participation and performance goals for teachers, students, and schools</td>
<td>CRP Team</td>
<td>May May May May</td>
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<tr>
<td>Develop comprehensive evaluation plan and management plan for submission to the Department of Education</td>
<td>CRS WCA</td>
<td>Jan - April Aug – Oct Aug – Oct</td>
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<tr>
<td>Assist participating schools in identifying potential AP teachers</td>
<td>CRP Team</td>
<td>April April April</td>
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<tr>
<td>Further refine online course equipment and finalize content support tools</td>
<td>CRP Team</td>
<td>July – Sept ongoing Ongoing</td>
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<tr>
<td>In both counties, launch tailored teacher, staff, parent, and community awareness program, including grant announcement event</td>
<td>CRP Team Communications</td>
<td>Jan ongoing Ongoing</td>
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<tr>
<td>Enroll teachers in NMSI systems</td>
<td>CRP Team</td>
<td>June June</td>
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<td>Order AP course equipment (e.g. science lab materials, graphing calculators, etc.)</td>
<td>CRP Team</td>
<td>July Aug Aug</td>
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<tr>
<td>Teachers attend summer institute</td>
<td>CRP Team</td>
<td>July July</td>
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<tr>
<td>Student study sessions begin</td>
<td>CRP Team</td>
<td>Sept Sept</td>
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<tr>
<td>Teachers attend AP two-day workshop</td>
<td>CRP Team</td>
<td>Nov Nov</td>
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<tr>
<td>Students complete mock exams</td>
<td>CRP Team</td>
<td>Feb Feb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students complete AP exams</td>
<td>LEAs</td>
<td>May May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect annual feedback from students, teachers, administrators, and staff to inform continuous improvement</td>
<td>CRP Team IT CRS</td>
<td>May May May</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AP scores received; verification of schools and participation confirmed; teacher and student financial awards distributed  | CRP Team Finance CRS | July | July |
--- | --- | --- | --- |
Make semi-annual updates to program to reflect feedback from key stakeholders, partners, and participants  | EVP/COO CRS CRP Team Grants Team | Dec; June | Dec; June | Dec; June |
Finalize data analyses  | CRS WCA CRP Team |  |  |  |

NMSI’s project leaders have experience managing large, complex, and rapidly growing projects. NMSI’s leadership team for this grant includes: (1) the CEO, who has successfully managed NMSI’s i3 validation and scale up grants as well as many large federal grants at other organizations; (2) the Executive Vice President / Chief Operating Officer, who oversees all program implementation and will lead implementation of the SEED grant; (3) the Chief Research Scientist, who will serve as the PI for this project; and (4) the Chief Financial Officer, who has overseen the budgets for several federal grants. The “CRP Team” includes a Content Director for each subject area (math, science, and English) and a Program Manager who acts as the account executive by traveling to the regional hubs frequently. In addition, the Grant Manager will manage all reporting requirements.

(3) The adequacy of procedures for ensuring feedback and continuous improvement in the operation of the proposed project

Performance management and continuous improvement are cornerstones of NMSI’s CRP. NMSI plans to implement a continuous improvement process that reflects the need to engage LEA and school-based partners (including teachers) and maintain flexibility to course-correct quickly. To enable continuous improvement, we will:

Use data-driven decision making to refine approach: NMSI’s online data management system
provides timely, Web-based quality control that allows NMSI to gather and analyze national-, regional-, and school-based data. This includes formative, benchmark, and annual summative data from participating schools. For example, when students begin their AP courses in the fall, NMSI analyzes increases in AP enrollment, broken out by subject, by discipline (math, science, English), by gender, by ethnicity, and by socio-economic status to ensure that all schools are on track for ambitious increases in AP scores across all subgroups. When AP results are released, NMSI analyzes AP scores to calculate percentage increases and to evaluate unexpected outcomes. These data allow NMSI to generate an effective and informative feedback loop that facilitates CRP’s constant improvement and targets lagging schools. Over time, program managers build the capacity of school-level teams to complete this goal-setting and review process on their own.

**Seek feedback at frequent intervals:** NMSI surveys AP teachers and mentor teachers at least twice annually to assess a wide range of measures including depth of content knowledge and satisfaction implementing instructional strategies learned during NMSI training sessions. Additionally, WCA has built feedback loops into the evaluation design. WCA will collaborate with NMSI on providing feedback to participating schools and focusing on instructional improvement, including workshops, webinars, or virtual professional development courses that all emphasize the use of data to improve school, teacher, and student processes.

**Implement an ongoing grant compliance structure:** NMSI’s Grant Compliance Committee meets monthly to assess financial and programmatic compliance. The committee is headed by the CFO. The committee will approve and improve the grant implementation plan, assess metrics, develop action plans for improvement, and communicate implementation progress.

*(4) The extent to which the applicant demonstrates that is has the resources to operate the*
project beyond the length of the grant, including a multi-year financial and operating model and plan; the commitment of any partners; evidence of broad support from stakeholders

NMSI has overseen $300 million in public-private funds since 2007. The organization had an annual operating budget of $30.8 million in 2014. NMSI has smoothly operated its i3 validation grant since 2011 and its i3 scale-up grant since 2015 and is therefore familiar with reporting and accountability standards at the federal level. The budget narrative reflects an overall project budget of $8,168,951, including a federal request of $6,126,572 and a non-federal matching budget of $2,042,379. Please see the budget narrative for more detail.

In preparation for the proposed project, NMSI carefully reviewed its staffing structure, and this project includes a budget request for additional staff where needed to successfully implement the project. We have identified staff with the highest qualifications, experience, and expertise to ensure fidelity of implementation. The budget narrative includes detailed information about time allocated by staff member to each project.

NMSI has significant financial capacity to continue to scale CRP nationally, thus increasing educator quality widely. To date, more than $300 million has been invested in NMSI from major foundations like the Bill & Melinda Gates Foundation and the Michael and Susan Dell Foundation; major corporations like IBM and ExxonMobil; and federal departments like the Department of Defense Education Activity and the Office of Naval Research, and others. NMSI does not seek a waiver of the SEED match requirement; our budget reflects a commitment to a 25% match of $2,042,379. We have secured commitments from both participating school districts to use existing non-federal resources to cover the required match. Please see letters from both DeKalb and Clayton Counties’ senior leadership to further clarify their commitment to the match (Other Attachments).
(d) Quality of the Project Evaluation

The evaluation plan is designed to achieve the following two aims: (1) explore the impact of NMSI’s College Readiness Program (CRP) on selected student outcomes; and (2) evaluate the fidelity of implementation and examine factors that may be associated with successful implementation.

This study consists of two different parts. (1) Comparative interrupted time series analysis (CITS) will be performed using a quasi-experimental (QE) design. Selected student outcomes will be compared before and after treatment implemented between treatment schools and comparison schools. Comparison schools will be selected using propensity score matching techniques described in later sections. (2) Fidelity of implementation of CRP and factors that may be related to successful implementation and selected students will be measured and evaluated within treatment schools.

Overarching Framework

The logic model for NMSI CRP shows that the innovative CRP intervention attempts to improve student learning outcomes by improving classroom teaching (see Figure 3, page 8). Thus, the evaluation design for this project addresses the working hypothesis that CRP implementation will produce intermediate outcomes in the form of improved conditions for learning and teaching and improved instruction. Our working hypothesis further asserts these intermediate outcomes will ultimately lead to higher student outcomes.

The evaluation questions are threefold as conceptualized in Raudenbush and Sadoff (2008): 1. What are the effects of the CRP treatment \((Z)\)\(^{15}\) on student outcomes \((Y)\)?

\(^{15}\)Z is a treatment indicator, which denotes \(T_{rt_k}\) in Equations 1 and 2.
2. What are the effects of the CRP treatment \((Z)\) on intermediate outcomes \((Q)\)?

3. What is the association between intermediate outcomes \((Q)\) and student outcomes \((Y)\)?

**Research Questions**

1. What is the impact of the program on the likelihood that students take STEM-related AP courses?

2. What is the impact of the program on the likelihood that students will achieve a qualifying score of 3 or better on STEM-related AP exams?

3. What is the impact of introducing the program on postsecondary outcomes of high school students, including matriculation and persistence?

4. What is the impact of the program on school-level rates of obtaining a score of 3 or higher (i.e., a score eligible for college credit) on STEM-related AP exams by gender/race/ethnicity?

5. What is the impact of the program on the likelihood of declaring a STEM-related major among students by gender/race/ethnicity?

6. What is the impact, by gender/race/ethnicity, of the program on stated declaration of a STEM-related major among students who graduated from treatment and comparison schools at the end of the first semester of enrollment in a postsecondary institution?

7. Are variations in program implementation systematically associated with differences in program outcomes?

8. What is the impact of the program on student report of teacher effectiveness?

9. What is the impact of the program on teachers’ self-reported effectiveness?

10. To what extent is NMSI’s program implemented with fidelity at the treatment sites?

11. What are the facilitators and barriers to implementation?

**Study Design and Statistical Comparisons**
Comparative Interrupted Time Series (CITS). To address our series of research questions, we propose to conduct a multi-year quasi-experimental (QE) study using a comparative interrupted time series (CITS) component. Comparison schools will be selected using propensity score matching techniques. Table 1 in the Evaluation Appendix presents the study design and sampling plan for the program implementation period. A total of approximately 20 schools will be sampled for the study. We plan to focus on students in Grades 11 and 12, with an average of 250 students in each grade per school, assuming that the likelihood of students taking AP course(s) in Grade 10 is very low. However, if any 10th grade students take AP course(s), they will be included in our analytic models.

During each year of the study period, the CRP impact will be evaluated using CITS design (CITS; Shadish, Cook, & Campbell, 2002)\textsuperscript{16}. In this design, we will plan to examine the change in the program schools’ performance using student-level outcome, when the program was implemented, benchmarked against the change for a similar set of comparison schools. A CITS involves two comparisons: comparing performance in the program schools before and after the program was implemented, and comparing this change in performance to the change in similar comparison schools. The first comparison (performance in the program schools before and after the program) identifies the program effect by assuming that a change in student outcome at the time the program was implemented is likely due to the program. That is, for example, if a student’s likelihood of taking AP course(s) increases more than we would expect based on pre-program trends after the program is implemented, this would suggest that the program had a positive effect. The second comparison strengthens this analysis by comparing the change in

student’s outcome in the program schools to the change in student’s outcome in other similar schools (comparison schools). As such, we control for changes that happened at the same time as the program by benchmarking the change in the program schools against the change in comparison schools. This method accounts for the effects of any event that affected both the program and comparison schools, assuming that all events influencing the program schools also affected comparison schools in the same way, and that there were no events that affected comparison schools but did not affect the program schools. Comparison schools are selected to be as similar to the program schools as possible in order to maximize the likelihood that these assumptions are met.

**Statistical Models.** The CITS model includes a treatment period variable (TrtPeriod\(_{ik}\)) which indicates whether student \(i\) in school \(k\) belongs to the pre-intervention period or the post-intervention period. In other words, since the CRP full intervention will begin in 2018-2019, students in the pre-intervention period take a value of 0 for this TrtPeriod variable, while those in the post-intervention period take a value of 1. The key parameter of interest in Equation 1a is \(\pi_{2k}\), which represents the difference in log-odd of taking an AP course for school \(k\) between students in the pre-intervention period and those in the post-intervention period.

\[
\pi_{2k} = \log \left( \frac{\pi_{2k} \pi_{1k} \text{Grade12}_{ik}}{1 - \pi_{2k} \pi_{1k} \text{Grade12}_{ik}} \right) = \pi_{0k} + \pi_{1k} \text{Grade12}_{ik} + \pi_{2k} \text{TrtPeriod}_{ik} \tag{1a}
\]

At Level 2, by including treatment indicator variable, Trt\(_{k}\) in Equation 1d, \(\gamma_{20}\) represents the difference in log-odd for students taking an AP course at the comparison schools between pre-treatment and post-treatment period, while \(\gamma_{21}\) captures such difference in the log-odd between the comparison and treatment schools. For example, if \(\gamma_{21}\) takes a statistically significant positive value, it indicates that likelihood of taking an AP course is increased more in the post-intervention period for the CRP treatment schools than for the comparison schools.
\[
\pi_{0k} = \gamma_{00} + \gamma_{01} \text{Trt}_k + \epsilon_{0k} \quad \epsilon_{0k} \sim N(0, \nu_0) \\
\pi_{1k} = \gamma_{10} + \gamma_{11} \text{Trt}_k + \epsilon_{1k} \quad \epsilon_{1k} \sim N(0, \nu_1) \\
\pi_{2k} = \gamma_{20} + \gamma_{21} \text{Trt}_k + \epsilon_{2k} \quad \epsilon_{2k} \sim N(0, \nu_2)
\]

If we are interested in whether the gender gap in likelihood of taking an AP course decreased more in the post-intervention period for the CRP schools than for the comparison schools, we need to include a gender variable and interaction term of gender and TrtPeriod\_ik variable in Equation 1a and also the resulting coefficient of interaction parameter needs to be modeled as a function of Trt\_k variable at Level 2. Additional models have been developed for intermediate outcomes, implementation mediation, and potential outcomes causal effects estimation, but due to space limitations they are not presented here but are available in detail in the Appendix.

**Statistical Power Analysis**

**Statistical power for impact on student participation in STEM-related AP courses.** To estimate power of the planned analysis, we draw on methods described in recent literature on power analysis for binary outcomes in group randomized trials (Donner & Klar, 1996; Spybrook, Raudenbush, Congdon, & Martinez, 2009). The power analysis for student participation in STEM-related AP courses determines the minimum detectable effect size (MDES) in participation percentage units. We assume a two-tailed test, with 0.80 power, and a Type I error level of 0.05. Below are the key parameters used in our power analysis:

**Number of schools.** We assume 20 treatment schools and 20 comparison schools in an impact estimation that will be conducted by academic year. Actual number of treatment schools should be greater than 20, so these estimates are conservative.

**Number of students per school.** We assume 250 students each in Grade 11 and Grade 12, resulting in a total of 500 students per high school.
**Base participation rate.** For comparison schools, we assume that an average of 4% to 10% of the students would participate in STEM-related AP courses. To approximate the participation rates for STEM-related AP courses from publicly available data, we obtain first the information about the average rate of participation in all AP courses, and second, the information about the ratio of participation in STEM-related courses to participation in all AP courses. According to the data on AP exam participation by state, the average participation rates in the three states stated in the RFP ranged from 10.4% to 19.7% (National Science Board, 2012, Table 8-12). Based on the data on exam participation counts by course, 36% of AP course participation is one of the STEM-related courses (College Board, 2013b). Lastly, we multiply the two pieces of information to obtain the base participation rate in STEM-related courses, resulting in the range of 4% (10.4 × 0.36) to 7% (19.7 × 0.36). Note that since students who take STEM-related AP courses do not necessarily take AP exams, our power calculation based on the rate of taking STEM-related AP exams gives us more conservative estimates.

**Intraclass correlation at the school level (ICCₜ).** The ICCₜ is the proportion of variance in the outcome that lies between schools relative to total variance. It is assumed to range from 0.10 to 0.15 based on previous literature about student achievement.¹⁷

Table 3 in the Appendix presents the minimum detectable effects in percentage under the scenario, described above. Under the assumption that the true participation rate of the comparison school students is approximately 4%, and the ICC ranges from 0.10 to 0.15, a

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¹⁷For student achievement outcomes, an ICC of 0.10 across schools within districts is in the range based on analysis of large-scale data sets (see e.g., Bloom, Richburg-Hayes, & Black, 2007; Jacob, Zhu, & Bloom, 2010; Schochet, 2005).
difference in participation rates of 7% or 11% between treatment and comparison students would be required to ensure at least 80% power of detecting the treatment effect.

**Statistical power for impact on student performance in STEM-related AP courses.**

Student performance in STEM-related AP courses is measured by a binary outcome that indicates whether a student obtains a score of 3 or higher on the AP exam. Thus, the power analysis for student performance in STEM-related AP courses uses the same methodology as above. It presents the results in two alternative ways: First, it determines the minimum detectable effect in percentage units; and second, it determines school sample sizes to detect 10% difference between treatment and comparison schools. Below we describe assumptions on key parameters used in the power analysis; the other assumptions remain the same as the above power analysis on student participation.

**Number of students per school.** We assume 35 to 100 students per high school take STEM-related AP courses across Grade 11 and Grade 12.

**Base passing rate.** For comparison schools, we assumed that an average of 2% of the students would obtain a score of 3 or higher in STEM-related AP exams\(^\text{18}\).

Table 4 in the Evaluation Appendix presents the minimum detectable effects in percentage under the scenario described above. Under the assumption that the passing rate of the comparison school students is approximately 2%, and the ICC ranges from 0.10 to 0.15, a difference in passing rates of 6% to 8% between treatment and comparison students would be required to ensure at least 80% power of detecting the treatment effect.

\(^{18}\) Based on the previous study drawing on the rollout of the NMSI in several states (Brown & Choi, 2015), an average of 2 percent of students obtained a score of 3 or higher in STEM-related AP courses.
Evaluating Fidelity of Program Implementation

The three goals of the implementation evaluation are to (1) provide formative feedback on CRP implementation; (2) measure implementation fidelity; and (3) describe the service contrast between the treatment and comparison schools. Research Questions 8, 9, 10, and 11 guide the implementation evaluation. The evaluation will examine the extent to which key components of the CRP are implemented as intended at the school level.

**Implementation evaluation design.** Administrators, teachers, and students in the treatment schools will be surveyed, and a subset of those participants will be identified for follow-up interviews or classroom observations. Likewise, a similar set of participants in the comparison condition (but fewer in number) will be surveyed and interviewed to gather information on how the AP program and courses are supported and delivered.

**Implementation fidelity indices.** To evaluate fidelity of implementation, we plan to adopt the existing CRP logic model and associated fidelity of implementation measures based on the logic model. The CRP logic model posits that the key components of the intervention are program management, teacher support, student supports, and incentives. Fidelity indicators have already been developed and field-tested (e.g., Sherman, Darwin, & Stachel, 2015). Fidelity will be measured separately for each key component of the intervention and threshold values defined (in collaboration with NMSI) to determine whether the intervention was implemented with fidelity. An existing implementation fidelity matrix has been developed that links the key components of the intervention to their indicators, the data source, the indicator scoring system, and the implementation threshold values.

**Implementation fidelity analyses.** School-level implementation fidelity will be analyzed by computing scores for each indicator and developing a fidelity measure for each key component.
For example, if the indicators for the program management component are early detection of problems, use of school-level data, use of student-level data, and providing performance feedback, each indicator would be scored 0 or 1. Program management would be assigned a fidelity score depending on how many indicators were met (e.g., none, low, moderate, high). Formative feedback on the CRP will be provided to NMSI through the fidelity measures and indicator scores on the key components. This information will be used to identify schools for more in-depth examination. For example, administrators and teachers at schools with low fidelity of implementation scores could be interviewed to allow us to better understand any barriers and challenges they are facing in implementing the CRP at their school.

**Outcomes and Key Variables**

The outcomes of interest for this study are measures of students’ STEM-related AP course experience that include (a) taking an AP course in mathematics and science; (b) STEM-related AP exam scores of 3 or higher (obtained via The College Board); and (c) declaration of STEM-related major in college (obtained via National Student Clearinghouse). In addition, measures from student and teacher survey instruments will be used as outcome(s) (obtained in collaboration with NMSI). Those include student reports of teacher effectiveness and teachers’ self-reported effectiveness that are considered as both outcome variables and mediating variables in analytic models. In addition to these outcomes, we plan to include selected student-level variables as covariates in our analytic models. For example, student background characteristics of gender, race, and ethnicity will be included in order to examine moderating effects of those variables on student outcomes. School background characteristics such as size, demographic composition, and school average of eighth grade state assessment score in mathematics will be considered to examine contextual effects.
Statistical Analysis Plan

A detailed statistical analysis plan is provided in the Evaluation Appendix.

Evaluation Personnel

Richard S. Brown, Ph.D. (PI) is Chief Research Scientist for NMSI and President/CEO of West Coast Analytics (WCA). Recognized statewide and nationally, Dr. Brown served as co-Chair of the California High School Exit Exam and served the National Assessment Governing Board (NAGB) as a reviewer of and advisor regarding their design plans to commission alignment studies between college readiness exams (SAT, Accuplacer) and the National Assessment of Educational Progress (NAEP). Further, he has served on numerous Technical Advisory Committees for educational research and policy agencies across the nation, including seven years on the Technical Advisory Group for the Standardized Testing and Reporting (STAR) program for the California Department of Education, the IES funded Regional Education Laboratory for the Mid-Atlantic region (REL-MA), the Assessing Data Modeling project at Vanderbilt University, and several test development and certification agencies, such as National Inspection, Testing, and Certification (NITC) organization. In addition, he was a founding member of the Board of Directors for the Education Policy Improvement Center, a leader in college and career readiness research. He is a member of the American Educational Research Association (AERA), American Statistical Association (ASA), the National Council for Measurement in Education (NCME), the American Psychological Association (APA), The Society for Research in Educational Effectiveness (SREE), and the International Testing Commission (ITC). Dr. Brown has been a faculty member at the USC Rossier School of Education, teaching courses in educational measurement, advanced statistics, and research methodology. He has also served on the academic faculty and as a Director for the Center for Research in Educational Assessment
and Measurement in the Department of Education, University of California, Irvine as well as Senior Researcher at the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at UCLA. Dr. Brown will provide overall conceptual and design leadership for the project, including evaluation studies and dissemination. Dr. Brown will allocate 25% FTE to this project for each of the years of the evaluation.

**Julia C. Phelan, Ph.D.** has more than 15 years experience conducting research in the area of assessment and evaluation. She has directed several multi-million dollar assessment projects at UCLA/CRESST, including an Investing in Innovation (i3) grant that incorporates a randomized control trial (RCT) of NMSI CRP effectiveness. In addition, she has developed assessment design and delivery software to enable and facilitate assessment administration. Dr. Phelan will serve as Project Director for this study, lead developing and implementing survey instruments, and communicating with NMSI and data vendors. Specifically, survey instruments will be developed and prepared after discussing with NMSI and implemented to sampled students and teachers under her supervision. Dr. Phelan will also supervise WCA personnel throughout the study (including the research assistants and interns). Dr. Phelan will allocate 30% FTE to this project for each of the years of the evaluation.

**Kilchan Choi, Ph.D.** will serve as Data Scientist for this project. Dr. Choi has rich expertise in developing and applying advanced statistical methodologies and hierarchical modeling to applied problems in multi-site evaluation, growth modeling, value-added models, and school effectiveness and accountability research. He will bring expertise and experience from his Institute of Education Sciences (IES) grant titled “Latent Variable Regression 4-Level/5-Level Hierarchical Model for Experimental, Quasi-Experimental Studies and Teacher and/or School Accountability.” He was also recently awarded a statistics/research methodology grant (Dr. Li
Cai: PI; Dr. Choi as Co-PI) from IES, titled “Novel Models and Methods to Address Measurement Error Issues in Educational Assessment and Evaluation Studies,” to develop proposed new statistical models, estimation methods, and statistical programs. New statistical models and analytic techniques from these grants will be instrumental for this proposed study. He also has extensive research experience in analyzing many states’ longitudinal student administrative databases for his studies with the Council of Chief State School Officers, U.S. Department of Education, and the Bill and Melinda Gates Foundation. Dr. Choi will lead statistical modeling and analytical and sampling aspects for the project. Dr. Choi will allocate 25% FTE to this project for each of the years of the evaluation.