Rural ACCESS: AP, College, and Career Excellence in STEM and Computer Science

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INTRODUCTION AND RESPONSE TO PRIORITIES

The National Math and Science Initiative (NMSI), a 501(c)(3) nonprofit organization, proposes an early-phase Education Innovation and Research (EIR) project, Rural ACCESS: AP, College, and Career Excellence in STEM and Computer Science, to increase the number of rural students engaged in and prepared for postsecondary Science, Technology, Engineering, and Math (STEM) coursework and accelerate their entry into STEM careers by deploying an innovative blended delivery model of NMSI's proven College Readiness Program (CRP).

NMSI was formed to address one of this nation's greatest economic threats — the declining number of students prepared to take rigorous college courses and pursue careers in STEM. CRP demonstrates that more students, especially high-need students, can master Advanced Placement® (AP®)[1] STEM coursework by helping schools become centers of college readiness and career exploration (for a detailed overview of CRP, see Appendix H2). In recognition of the proven approach, CRP has received two Investing in Innovation Funding (i3) grants to help reach more than 1,000 schools and drive 175,000 AP *qualifying scores (3 or higher on a 5-point scale)*. During this project, we will partner with roughly 20 percent of North Dakota's *rural high schools (those located in rural locale codes)* to grow AP enrollment by 140 percent and increase the number of qualifying scores by 80 percent from baseline at each school. Ultimately, we expect to scale this approach across rural communities, which house 28 percent of public schools nationwide (National Center for Education Statistics 2016).

Absolute Priority 1: Demonstrates a Rationale

NMSI's proposal meets Absolute Priority 1 by replicating CRP's proven model in rural

[1] Advanced Placement® and AP® are registered trademarks of the College Board.

settings and implementing an innovative *blended delivery mechanism (one that combines in-person and online modalities)*; for detail, see Appendix H5. This evidence-based, field-initiated innovation will scale NMSI's ability to reach previously underserved students while maintaining high effectiveness. We cite research (see Appendix G) reflecting a positive, statistically significant impact of CRP on AP enrollment and qualifying scores. We also share findings related to the emergent literature on online and blended learning (OBL) programs suggesting that effectiveness is tied to program design, content, and promising practices related to delivery. By incorporating proven content with evidence-based OBL formats, we expect that NMSI's blended delivery CRP will drive the student outcomes equal to those achieved by standard CRP delivery while greatly increasing the volume of high-need schools that NMSI can serve.

Absolute Priority 3: Field-Initiated Innovations — Promoting STEM Education, With a Particular Focus on Computer Science

This proposal also meets Absolute Priority 3 by prioritizing student enrollment and achievement in AP STEM — particularly computer science — courses through blended delivery CRP at rural schools. CRP career augmentation and mentorship aspects will provide students with work-based STEM learning experiences to foster a future sense of self with STEM as a postsecondary pathway (for more detail, see the Career Exploration section in Appendix H5).

Invitational Priority 1: Personalized Learning

Blended delivery CRP meets Invitational Priority 1 by offering high flexibility for tailored learning experiences through online supports that offer students individualized pacing and just-right instructional support (see Appendix H5 for more detail).

Rural Eligibility

NMSI is a nonprofit organization in partnership with local education agencies (LEAs) with an urban-centric district locale code of 32, 33, 41, 42, or 43. Appendix H1 and our memoranda of understanding (MOU) in Appendix C include a list of partner LEAs.

SIGNIFICANCE

The National Significance of the Proposed Project

Ensuring all students have access to and excel in STEM is essential for our nation's economic growth (Langdon 2012). Growth of the U.S. STEM job market has far outpaced production of STEM degrees. This makes U.S. STEM dependent on foreign talent (US News and World Report 2016). Our STEM knowledge capital, which fuels innovation and ensures economic competitiveness, is at risk.

Rural students are particularly underprepared for STEM. Students who succeed in rigorous, advanced academics in high school are more likely to pursue and complete four-year college degrees, placing them on a trajectory for high-potential economic and employment (College Board 2014). STEM, and particularly computer science, career fields are among the most lucrative in the U.S. but require postsecondary education (US News and World Report 2016). Yet many rural high schools can't offer any AP STEM due to acute teacher shortages; on average, 62 percent of U.S. rural schools experience a STEM teacher vacancy (Player 2015). This puts rural students at a significant disadvantage in developing college readiness skills, mindsets, and habits. In 2015, only 19 percent of the rural population held a bachelor's degree (US Department of Agriculture 2017), compared to the 33 percent urban average (Pew Research Center 2014).

NMSI's CRP increases the number and diversity of students taking and earning qualifying scores in AP STEM, with a growing focus on computer science, by transforming partner schools into centers of college readiness. CRP makes a dramatic difference in only one year and transforms school culture over three years to sustainably support achievement beyond the duration of the grant period (see pg. 11 for more on outcomes). By supporting and motivating more youths to pursue postsecondary education — with a focus on 1) STEM and computer science, and 2) underserved rural regions — this project has the potential to mitigate threats to economic growth overall and the academic and occupational futures of rural youths.

The Extent to which the Proposed Project Involves the Development or Demonstration of Promising New Strategies that Build On, or Are Alternatives to, Existing Strategies

In this early-phase application, we request support to apply and evaluate the strategies using a blended online delivery model to reach students in rural settings; this project represents the first time that this would happen at this scale. We propose this project design because it will create a promising new strategy that builds on our proven CRP approach (see Appendix H2 for an overview) while addressing historical barriers to implementation within that context.

These strategies include 1) deploying a blended online delivery model, 2) leveraging existing relationships within rural communities to support access to and adoption of this model, 3) building the capacity of STEM teachers in rural areas to support CRP, and 4) reducing the program cost to participate in CRP. Appendix H3 summarizes the barriers we have experienced with our traditional CRP program and the strategies we will deploy to ensure equitable access.

The Extent to which the Proposed Project Demonstrates a Rationale

In this section, we provide evidence that the rationale for this project is 1) informed by evaluation findings that **<u>CRP itself</u> meets or exceeds the "moderate" evidence requirement** demonstrating that the strategy will improve student outcomes; and 2) informed by **research that <u>modality</u> of delivery method for curriculum is irrelevant —** instead, the quality of the curriculum delivered and the effectiveness of the delivery method affects student outcomes. We also provide a summary of how NMSI and CRP have evolved (see pg. 8 in this narrative).

CRP Effectiveness: A substantial body of evidence indicates that CRP **not only increases the probability that students will take and earn qualifying scores on AP exams, hence enhancing their achievements and increasing their college readiness** (Brown R.C. 2015; Holtzman 2010), **but also has significant and longer-term positive postsecondary and economic impacts** (Jackson 2007, 2010, 2014; Sherman 2014, 2015). The program's consistent elements produce reliably successful and sustained outcomes across settings, states, subject areas, and students, including those students traditionally underrepresented in STEM.

Listed in Appendix G, the studies upon which we focus represent an array of well-designed, well-implemented research that presents evidence of CRP's effectiveness, 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 strong evidence of effectiveness that exceeds the threshold required for the early-stage EIR grant. Holtzman (2010), using a comparative interrupted time series (CITS) design, found that in its first year, CRP (formerly called **the "APTIP program") had a positive and statistically significant impact on student enrollment in AP courses in mathematics, science, and English, as well as on their success in passing the related AP examinations with a score of 3 or higher.** Notably, CRP implementation was associated with a 12-point increase in the percentage of students taking at least one mathematics, science, or English AP exam, showing growth of **more than a full standard deviation.**

Sherman (2014, 2015) provides 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. Using a CITS design, they compared the changes in average AP outcomes over time of high schools implementing CRP (N=18) against changes in matched comparison schools that were not implementing the program (N=18). The study's first-year outcomes showed that CRP schools significantly outperformed the comparison schools both in the percentage of students taking AP STEM exams and in the percentage of students earning qualifying exam scores in these subjects. In the second year, treatment schools significantly outperformed comparison schools in the percentage of students taking AP exams and the percentage earning qualifying scores across all subject areas (see Appendix H10).

Jackson found that the program had positive effects on AP course enrollment, SAT/ACT scores, and college matriculation (Jackson 2007), as well as on college GPAs and college persistence (Jackson, 2010). Jackson (2014) also related CRP participation to enduring labor-market outcomes, such as wages. Brown (2015) employed a potential outcomes modeling approach on a large sample of treatment schools (N=287) 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 scores. Their results indicate substantial and significant increases in both AP exam-taking and qualifying score-earning for all students, female students, and other student subgroups who have historically been underrepresented in STEM, when analyzed separately (average effect size: 0.64).

Most recently, Sherman (2017) deployed a CITS design to study the implementation of CRP across 58 high schools in Colorado and Indiana. Schools implementing CRP demonstrated significantly larger increases in the share of students taking and passing AP tests in targeted areas relative to comparison schools, and, importantly, gains were sustained over time.

Taken together, the results of these studies suggest that CRP participation can positively affect students' achievement; college readiness; persistent enrollment; and, potentially, lifetime earnings. We also expect this project will help practitioners and policymakers better understand the CRP model, how it is scaled, and its continued educational and economic impacts.

Impact of blended modality: Online and blended learning programs are still relatively new to the education sector, and their design elements and application vary widely.

In addition to the strong evidence that supports the CRP model, other research suggests that the method in the delivery method is irrelevant; it is the quality of the curriculum delivered and the effectiveness of the delivery method that affects performance (Clark 2012). Clark argues that the instructional method is important to generating learning, not the medium through which it is delivered, stating, "All methods required for learning can be delivered by a variety of media and media attributes" (Clark 2012; p. 181). Consistent with this perspective, we expect the positive effects of NMSI's CRP program will persist in an adapted delivery model.

The emergent literature on online and blended learning (OBL) programs suggests that effectiveness is tied to program design, content, and promising practices related to delivery (Amaka 2017). Promising practices related to delivery include interactivity, navigability, (a)synchronicity, flexibility, media richness, ease of use, individualization, mobility, proximity and responsiveness" (Amaka 2017). In Appendix H5, we describe how blended CRP addresses these attributes. By incorporating proven content with evidence-based OBL formats, we expect that NMSI's blended delivery CRP will drive the same student outcomes as seen in standard delivery while greatly increasing the volume of high-need schools that NMSI can serve.

Logic Model for Project: Alterations to the existing CRP logic model are listed below (see Appendix G for the logic model; more detail on each component can be found in Appendix H5). The primary effect of these changes on outputs is that barriers to delivery in rural schools are eliminated, ensuring that all students can access CRP and enroll in AP.

- Schools' AP teachers are supported and supplemented online to ensure school access to AP; training only offered in person now have online alternatives, and NMSI and an expanded portfolio of teacher/student support materials can be accessed online.
- Both teacher mentoring and student coaching are available online for rural schools.
- Curriculum exploration and mentorship opportunities with STEM professionals are available online, offering rural students the opportunity to investigate STEM career pathways.
- Technology procurement eliminates access to technology as a barrier for students.
- Capacity-building in rural schools facilitates logistics/scaffolding development to support AP coursework; technical assistance can be delivered online for rural schools.
- Program enablers: To reduce AP barriers at rural schools, NMSI will seek out high-potential partners, spread awareness about the AP value proposition, continue to evolve blended delivery, and advocate for the categorization of AP computer science courses as core STEM.

The Extent to which the Proposed Project Represents an Exceptional Approach to the Priority or Priorities Established for the Competition

This project focuses on evolving CRP delivery, with a focus on computer science courses, to alleviate *"STEM deserts" (geographies with opportunity gaps in STEM educational outcomes or are lacking components of a successful STEM system)*. Our 14 proposed rural LEA partners comprise approximately 10 percent of rural high schools in North Dakota. Their student population compositions range from 0 to 77 percent of students receiving free or reduced-price lunch, and some serve high concentrations of Hispanic and Native American/Alaska Native students — groups traditionally underrepresented in STEM fields. NMSI is well positioned to guide further scale-up with these and future rural partners based on its track record in North

Dakota thus far; of the 38 Computer Science A exams and 56 Computer Science Principles exams taken in the state last year, all but one were at NMSI schools (College Board 2016).

Several factors differentiate CRP as an exceptional program. First, as illustrated by our logic model (for more detail, see Appendices G and H5), CRP is founded on a set of highly standardized and quantifiable program and performance metrics that can be gathered and analyzed on a national level. Below, we outline several other factors that enable NMSI's Rural ACCESS project to uniquely address the priorities of the EIR grant competition:

1. *Program focus on high school STEM and computer science:* CRP tackles the STEM crisis in high school, when evidence shows it is difficult to bring those students who lag behind up to speed (Dougherty 2006). CRP uses vertical teaming, curriculum alignment, and scaffolding to build a pipeline of students prepared for rigorous coursework (C. Jackson 2010).
2. *Program delivery accommodates underserved students in rural locale codes:* A blended online CRP delivery model will reach students in rural districts who may not otherwise have access to rigorous STEM and computer science academics due to local teacher and resource shortages. This removes access as a driver of the achievement gaps in STEM.
3. *Program structure designed to work and build capacity within the framework of existing schools:* CRP is highly effective at integrating its model into existing schools, standing apart from similar programs that, in contrast, require the resource-intensive launch of a new school or organization to house their initiatives (Jackson, 2014).
4. *Blended online program delivery drives access and personalized learning:* The flexibility and technology that accompany blended delivery overcome constraints for personalized learning often seen in rural schools due to teacher shortages.
5. *Organizational focus on dissemination of best practices encourages replication:* NMSI is

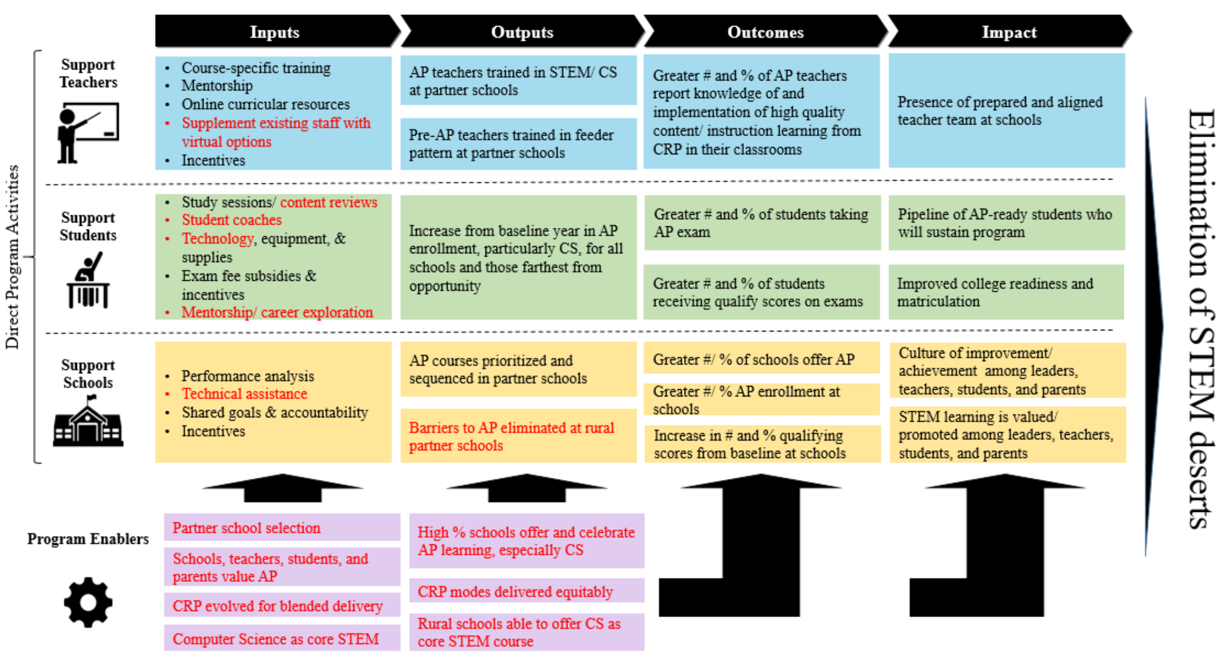
committed to catalyzing national-level STEM outcomes. NMSI operates several programs that analyze and report on the current state of STEM education, foster partnerships with other leading STEM programs, and convene stakeholders to share best practices. These initiatives will serve as forums for discussion and potential seeds for replication of our grant program.

QUALITY OF PROJECT DESIGN AND MANAGEMENT PLAN

The Extent to which the Goals, Objectives, and Outcomes to be Achieved by the Proposed Project are Clearly Specified and Measurable

Objective: This project will build on the proven effectiveness of CRP to dramatically increase the number of students taking and earning qualifying scores on AP STEM (especially computer science) exams in rural schools. The project logic model (below and in Appendix G; see detail on components in Appendix H5) identifies key program factors, as well as updates to the original CRP logic model in red font, that accommodate the needs of rural schools.

Figure 1. Blended CRP Logic Model



Goals and Outcomes: By the end of the grant period, NMSI will expand its footprint to 30 North

Dakota high schools, serving approximately 20 percent of the state's rural high schools. Based on the success of this project, which is designed to enable exploration of new ways to address challenges that rural schools face and build evidence of the effectiveness of our practices, we will replicate and scale this approach in rural schools across the country. Alabama, New Mexico, and Washington have already expressed interest in adopting blended delivery CRP. Within each partner school, we aim to maintain historical levels of CRP effectiveness:

- Student enrollment, particularly for those students who have been furthest from opportunity due to learning differences, situational challenges, or other factors, in AP courses will increase from the baseline year by at least **80 percent** in the first year and **140 percent** over three years. *Measurement:* Course enrollment data shared by schools, collected annually
- The number of qualifying scores on AP STEM (including AP computer science) exams will increase by at least **70 percent** after the first year of CRP and at least **125 percent** over the three-year grant period. *Measurement:* AP qualifying scores, collected annually.
- All participating teachers will report an **increase from baseline** knowledge and use of content and effective instructional strategies. *Measurement:* Formal and informal surveys, site visits, and NMSI mentor feedback, collected annually.
- Schools will make **necessary changes** to facilitate expanded access to AP courses and prioritize student success in these courses. *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, all collected annually.

In addition to CRP's impact, partner schools will benefit from NMSI's Laying the Foundation (LTF) program. LTF trains teachers to facilitate students' progression through the academic pipeline toward advanced coursework starting as early as third grade (for program overview, see Appendix H4). Together, CRP and LTF holistically revitalize the culture of learning in schools, fostering an achievement mindset and a sense of future self that positions STEM as a possibility for each student. North Dakota has already committed enough funding to enroll all educators of grades three through 12 employed in state LEAs in LTF, and NMSI has the capacity to serve them. Should all educators participate, all **49,000 rural public school students** in North Dakota could form an AP STEM pipeline.

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

- Other rural schools nationwide will see NMSI's impact in North Dakota and adopt and/or replicate blended CRP to drive similar results. In each state that participates in CRP, NMSI hopes to achieve a similar scale (**at least 20 percent of rural schools**).
- School culture in partners will shift to encourage and **support high academic achievement in AP; STEM**, particularly computer science; as well as blended delivery for all students.
- School mindsets about blended delivery will shift from skepticism to enthusiasm, driving **increased use from the baseline of high-quality online programs** to reach all students.
- Program schools will continue to make **gains in AP each year**. The percentage of students enrolled in AP and earning qualifying scores will meet or exceed the national average rates of 37.7 percent and 22.8 percent, respectively (College Board 2017).
- A pipeline of **AP-ready students** will exist at rural schools and high schools, ensuring that students are prepared for rigorous, college-level coursework.
- **College matriculation and persistence**, particularly in postsecondary STEM and computer science, will increase for students who have been in NMSI's program to meet or exceed the average national matriculation rate of 69.7 percent (Bureau of Labor Statistics 2017).

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

Management Plan: NMSI has developed a robust management plan to ensure project objectives are met on time and within budget. The table below summarizes responsibilities, timelines, and milestones for accomplishing key project tasks.

Table 1. Key Activities and Milestones

Goal	Objectives	Measures	Activities and Milestones	Owner	School Year and Quarter				
					18/19	19/20	20/21	21/22	22/23
Dramatically increase the number of students taking and earning qualifying scores on AP STEM, and especially AP computer science, exams in rural schools	Increased enrollment in AP courses by students in each school	Course enrollment data shared by schools, collected annually	Finalize components of blended model and pilot in ND	CEO, COO	Q1-Q4				
			Build relationships among rural schools and LEAs	PM, CRP team	Ongoing				
			Execute MOUs with rural schools for following year	COO, CFO	Q4	Q4	Q4	Q4	Q4
			Support community AP/STEM awareness programs in partner communities	COO, PM	For following year: Q2-Q3: presence on campus, information sessions, 1:1 meetings with students/parents, letters home Q4: letters home, enrollment instructions				
			Enroll mentor teachers, peer coaches, and students for following year	PM, CRP team	Q1	Q1	Q1	Q1	Q1
			Procure supplies, equipment, and technology as needed for following year	CFO, PM	Q2-Q3	Q2-Q3	Q2-Q3	Q2-Q3	Q2-Q3
	Increased knowledge/ use of content/ instructional skills by teachers	Formal and informal surveys, site visits, and NMSI mentor feedback, collected annually.	AP teachers attend summer institute for following year	CRP team	Q4	Q4	Q4	Q4	Q4
			Teachers for grades 3–12 attend LTF for following year	CRP team	Q4	Q4	Q4	Q4	Q4
			Run teacher training, student content reviews, and mentoring/coaching	CRP team		Q1-Q3	Q1-Q3	Q1-Q3	Q1-Q3
	Increased number of qualifying scores in each school	AP qualifying scores, collected annually	Students complete AP exams	CRP team		Q3	Q3	Q3	Q3
			Receive and analyze AP scores; distribute awards	ED, CFO		Q4	Q4	Q4	Q4
	Schools make necessary changes to facilitate expanded access	Schools' adding/ sequencing AP courses; administrator and teacher implementation of programmatic feedback, all collected annually	Support and troubleshoot implementation at schools	CRP team	Ongoing				
			Conduct focus groups with rural partners	ED		Q1, Q3	Q1, Q3	Q1, Q3	Q1, Q3
			Collect feedback from students, teachers, administrators, and staff via surveys	ED		Q1, Q3	Q1, Q3	Q1, Q3	Q1, Q3
	Effectively manage blended delivery CRP Program	Evaluation results, ormal and informal surveys, site visits	Finalize design of evaluation plan	CEO, ED	Q1-Q4				
			Receive and analyze AP scores; distribute awards	ED, CFO		Q4	Q4	Q4	Q4
			Make program updates to reflect feedback from key stakeholders and participants	ED, COO		Q2, Q4	Q2, Q4	Q2, Q4	Q2, Q4

Highly Qualified Project Team: NMSI has identified staff with the highest qualifications, experience, and expertise in managing large, complex projects — including successful administration of the 2010 validation i3 and 2015 scale-up i3 grants — to oversee implementation. The team for this grant includes 1) the chief executive officer (CEO), who will lead implementation as project director; 2) the chief financial officer (CFO), who will oversee the budget/compliance; 3) the chief operations officer (COO), who will oversee program implementation; 4) the evaluation director (ED), who is responsible for working with the evaluation partner to support the external evaluation; and 5) the program manager (PM), who will lead on-the-ground relationships and initiatives for program implementation.

Outlined here are summaries of the team's qualifications; detailed resumes can be found in Appendix B: **1) Bernard Harris, CEO:** A founding NMSI board member with 25-plus years' experience in STEM education, Dr. Harris became the CEO of NMSI in 2018. Dr. Harris is a veteran astronaut who brings research and evaluation expertise built at NASA, where he developed in-flight medical devices to extend astronaut stays in space. In addition to his public leadership and groundbreaking service at NASA (as the first African American to spacewalk), Dr. Harris has a B.S. in biology from the University of Houston, a M.A.M.S. from the University of Texas Medical Branch at Galveston, an M.B.A. from the University of Houston, and an M.D. from Texas Tech University School of Medicine. **2) Tammy Knapp, CFO:** Tammy has extensive grant administration experience, including leading NMSI's successful 2010 and 2015 i3 grant compliance. She is responsible for all financial matters at NMSI, including budget development oversight and financial reporting and compliance related to numerous public and private grants. **3) Stacy Miles, COO:** Stacy leads program and operations for NMSI, overseeing the program, teaching and learning, strategic initiatives, IT, and human capital teams with an overall focus on program strategy and organizational sustainability. She brings 20-plus years of education leadership experience in developing and supporting teachers and students, having previously worked at the University of Texas in student support services, Citizen Schools-Texas as executive director and chief program officer, and The New Teacher Project (TNTP) as partner. Stacy holds an M.A.Ed. from the University of Texas at Austin and a B.A. from

Southwestern University. **4) Gina Del Corazon, ED:** As director of data and analytics, Gina leads all internal organizational data and analytics strategy as well as evaluation of NMSI's nationwide programs. She brings experience coordinating external evaluations of program effectiveness. Gina previously worked as a site manager for TNTP programs; as such, she is highly familiar with program implementation and operations. She has an M.A. in economics from the University of California and a B.A. in government from Smith College, and she is a Ph.D. candidate at Princeton University. **5) Toni Schneider, PM:** Toni has overseen the launch of CRP's blended delivery pilot in North Dakota and brings expertise in working with rural schools to develop STEM and AP programming, as well as an extensive set of relationships with district and state education agency (SEA) stakeholders that are critical during the program's rollout. Toni has a deep understanding of CRP as NMSI's most tenured PM, having worked with a broad cross-section rural, military, suburban, and urban schools. Prior to this project, Toni served as mathematics coordinator for NMSI and previously worked as a math teacher. As one of 30 graduates from her rural high school class, she is passionate about providing rural students STEM and computer science access. She has a B.A. in mathematics from Tarleton University.

NMSI's Teaching and Learning team will support project leadership and is responsible for curriculum and design as well as training, in addition to the existing CRP team; an organizational chart can be found in Appendix H6. Finally, West Coast Analytics will serve as NMSI's external evaluation partner (for more detail, Project Evaluation section on pg. 18).

The Extent to which Performance Feedback and Continuous Improvement are Integral to the Design of the Proposed Project

Performance management and continuous improvement are cornerstones of CRP, as the program must address the needs of LEA and school-based partners while maintaining flexibility to course correct quickly. To accomplish this, NMSI will implement the following mechanisms:

1. *Use data-driven decision-making to refine an approach:* NMSI's online data management system provides timely quality control that gathers and analyzes national-, regional-, and school-based data. This includes formative, benchmark, and annual summative data from participating schools on student enrollment, qualifying scores, and program management to facilitate constant improvement and target lagging schools.
2. *Seek formal feedback at regular intervals:* NMSI will regularly survey school leaders, teachers, mentors, students, and other stakeholders who interact with the program to assess a wide range of performance measures, including depth of content and instructional knowledge, and effectiveness of program management. NMSI will also conduct focus groups twice annually with the same stakeholder groups to gain insight on strengths and opportunities for improvement in the blended delivery model.
3. *Accessible real-time support and informal feedback:* NMSI program managers will meet with school partners to support day-to-day implementation. They will also provide coaching for school leaders based on CRP KPIs (see #5 below) to ensure alignment with team goals.
4. *Implement an ongoing grant compliance structure:* NMSI's Grant Compliance Committee meets monthly to assess financial and programmatic compliance. The committee consists of NMSI staff members who will approve and improve the grant implementation plan, assess metrics, develop action plans for improvement, and communicate implementation progress.
5. *CRP key performance indicators (KPIs):* CRP has a set of KPIs (see Appendix H7) aligned to annual strategic priorities, which include and extend beyond the grant project's results. The team regularly tracks and reports KPIs to allow for timely course correction.

The Mechanisms the Applicant Will Use to Broadly Disseminate Information on Projects to

Support further Development or Replication

NMSI is committed to driving STEM progress by illuminating proven and promising STEM programs, such as this grant project. As such, NMSI has resources to facilitate widespread adoption and expansion of blended delivery CRP. Mechanisms include sharing lessons learned via NMSI's reputable publications; a "seat at the table" at high-profile events, such as the U.S. News STEM Solutions Conference and the College Board AP Annual Conference; and a national network of STEM experts. The design of this project also has several features specifically intended to promote replication:

- Over the course of the three-year program, CRP will build operations and financial/ fundraising capacity in partners so they can self-sustain work after the grant period ends.
- NMSI will hold CRP information sessions open to all educators employed by our partners (and in surrounding regions), both online and in person, to build buy-in for future expansion.
- After the grant period, we will publish lessons learned on NMSI's teacher portal and website to help teachers effectively apply content-rich instructional techniques via blended delivery.
- Both NMSI and West Coast Analytics will disseminate West Coast Analytics' independent evaluation at regular conferences and workshops, and in peer-reviewed publications. West Coast Analytics will collaborate with NMSI to provide feedback to participating schools.

QUALITY OF PROJECT EVALUATION

This evaluation is designed to 1) explore the impact of CRP on selected student outcomes, and 2) evaluate the fidelity of implementation and examine factors related to successful implementation. The following describes the overarching evaluation framework, the specific plan for each sub-component, key personnel, and plans for the dissemination of findings.

This study consists of two parts: first, a comparative interrupted time series (CITS) design to meet the WWC evidence standards with reservations. Selected student outcomes, specifically AP course enrollment and exam scores, and pursuit of STEM majors in college will be compared before and after CRP implementation for students at the treatment schools. These students' outcomes will be compared to propensity score-matched students at comparison schools. Second, treatment schools will be assigned a fidelity of implementation score based on identified factors related to successful implementation. The level of implementation will be assessed based on the extent to which teachers use CRP content and associated effective instructional techniques as well as to the extent the school exhibits a culture of achievement and continuous improvement. The fidelity of implementation score will be analyzed to determine the extent to which varying levels of implementation correlate with student outcomes.

Overarching Framework

Consistent with the CRP logic model (see Appendix G), the evaluation design addresses the working hypothesis that CRP implementation will produce intermediate outcomes in the form of improved conditions for learning and teaching, and, subsequently, the desired student outcomes — specifically, more students enrolled in AP courses, a greater percentage of students who earn qualifying scores, and more students pursuing STEM majors. The following questions guide the analytic approach of the effect and relationships between level of implementation and outcomes: 1) What are the effects of the CRP on students' AP a) enrollment, b) scores on exams, and c) pursuit of STEM majors? 2) What are the effects of the CRP on intermediate outcomes (i.e., fidelity of implementation, specifically a) teachers' use of the CRP content, b) teachers' use of CRP-associated instructional strategies, and c) the extent to which the school culture focuses on achievement and continuous improvement? 3) What is the association between level of CRP implementation and student outcomes?

The following describes the analytic approaches used to address these questions. First, the variation of implementation level is assigned to each treatment school. Because students are nested within schools, two-level hierarchical linear modeling (HLM) (Raudenbush, 2002) will be used to account for this shared variance at the school level and its associated impact on student outcomes. As part of the hierarchical model building process, student background characteristics, such as gender, race, and ethnicity, will be included to examine the differential effects of CRP. The second question will be examined using a three-level HLM to account for the shared variance of teachers within schools and students assigned to specific teachers within schools. Standard logistic regression would be inadequate because measurement errors would be inflated due to assessing error independently at each level. The third question will be examined using a two-level HLM, where students are nested within teachers or schools (i.e., share variation in implementation because it is assigned at the school and/or teacher level). This addresses the assumption that there is a small number of STEM-related AP teachers (e.g., one or two in mathematics) per school, so teacher level and school level may be the same. To account for potential measurement error with this approach, an advanced latent variable (LV) modeling approach will be included. See Appendix H11 for a CITS component that will be presented in detail along with both research design and analytic models.

Research Questions

The first six questions seek to estimate CRP's impacts on student outcomes. Question 7 seeks to estimate mediation effects of program implementation. The questions are: (1) What is the impact of the program on the likelihood that students take STEM AP courses? (2) What is the impact of the program on the likelihood that students will achieve an AP STEM qualifying score? (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 an AP STEM qualifying score by gender/race/ethnicity? (5) What is the impact of the program on the likelihood of declaring a STEM major among students by gender/race/ethnicity? (6) What is the impact, by gender/race/ethnicity, of the program on the stated declaration of a STEM 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) To what extent is NMSI's program implemented with fidelity at the treatment sites? (9) What are the facilitators and barriers to implementation?

Study Design and Statistical Comparisons

CITS: To address our series of research questions, we propose to conduct a three-year (baseline plus two implementation years) quasi-experimental study using a CITS component. Comparison schools will be selected using propensity score-matching techniques. In the event matching techniques do not result in baseline equivalence on predictor variables, propensity weighting will be deployed to ensure baseline equivalence. Appendix H11 presents the study design and sampling plan for the two years of the program implementation period.

CRP impact will be evaluated each year of the study (Baseline, Implementation Years 1, 2) to examine changes in program schools' performance using student-level outcomes and when the program was implemented, benchmarked against the change for a similar set of schools.

Appendix H11 depicts a framework of statistical comparisons for each year. In Baseline Year, CITS analysis compares students in grades 11 and 12 in 2016/17 and 2017/18 with the baseline implementation students in 2018/2019. Students in 2016/17 and 2017/18 will be served as pre-baseline benchmarking students throughout the study years in CITS analysis. CITS analysis in Year 2 will add first-year implementation students in 2019/20 to the Baseline Year CITS study sample. Likewise, in Year 3 CITS analysis, students in 2020/21 will be added to the CITS Year 1 implementation sample as second-year implementation students.

Statistical Power for Impact on Student Participation in STEM-Related AP Courses: The power analysis[2] for student participation and outcomes in AP STEM courses determines the minimum detectable effect size (MDES) in participation percentage units. Assuming a two-tailed test, with 0.80 power, and a Type I error level of 0.05, we set the following parameters:

- *Number of schools:* We assume 20 treatment schools and 20 comparison schools in an impact estimation that will be conducted by academic year.
- *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 4-10 percent of the students would participate in AP STEM courses, based on our experience with similar investigations in states across the country.
- *Number of students per school:* We assume 20-100 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 percent of the students would obtain a score of 3 or higher in AP STEM exams.[3]
- *Intraclass correlation at the school level (ICC_s):* The ICC_s is the proportion of variance in

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[2] Power analysis for binary outcomes in group randomized trials (Donner 1996; Spybrook 2009)

[3] Based on the previous study drawing on NMSI's rollout in several states (Brown R. C., 2015), an average of 2 percent of students obtained a qualifying.

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.[4]

Table 3 in Appendix H11 presents the MDES in percentage under the scenario described above. Under the assumption that the true participation rate of comparison school students is approximately 4 percent, and the ICC_s ranges from 0.10 to 0.15, a difference in participation rates of 7 or 11 percent between treatment and comparison students is required to ensure at least 80 percent power of detecting the treatment effect. Table 4 presents the MDES in percentage under the scenario described above. Assuming the passing rate of the comparison school students is approximately 2 percent, and the ICC_s ranges from 0.10 to 0.15, a difference in passing rates of 6-8 percent between treatment and comparison students is required to ensure at least 80 percent power of detecting the treatment effect.

Evaluating Fidelity of Program Implementation

Implementation Evaluation Design: The fidelity of implementation study will be part of the overall study design described in Section 3. Administrators, teachers, and students in the treatment schools will be surveyed to assess the extent to which they perceive the school culture focuses on achievement and continuous improvement. A subset of administrators will be identified for follow-up interviews. A subset of teachers will be identified for classroom observations using an implementation rubric based on the key features of CRP described below.

Implementation Fidelity Indices: The CRP logic model posits that the key components of the intervention are program management, teacher support, student supports, and incentives.

[4] For student achievement outcomes, an ICC_s of 0.10 across schools within districts is in the range based on analysis of large-scale data sets (Bloom 2008; Jacob 2010, Scochet 2005).

Related fidelity indicators have already been developed and field-tested for validity and reliability (e.g., Sherman 2014). Fidelity will be measured separately for each key component of the intervention and threshold values defined to determine whether the intervention was implemented with fidelity. An existing implementation fidelity matrix links the key components of the intervention to their indicators, the data source, the indicator scoring system, and the implementation threshold values.

Implementation Fidelity Data Sources: Participant surveys will be administered at all treatment schools, with follow-up interviews and observations conducted in a subset of schools selected based on NMSI's recommendations and the degree of implementation fidelity (e.g., high- and low-implementation schools).

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 and 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 CRP implementation will be provided to NMSI to identify schools for more in-depth examination. For example, educators at schools with low fidelity of CRP implementation scores may be interviewed to surface important barriers and challenges.

Outcomes and Key Variables

The outcomes of interest for this study are measures of students' AP STEM course experience that include a) taking an AP course in mathematics and science, b) receiving qualifying scores on AP STEM exams (obtained via the College Board), and c) declaring a

STEM major in college (obtained via National Student Clearinghouse). In addition, measures from student and teacher survey instruments (e.g., student reports of teacher effectiveness and teachers' self-reported effectiveness) will be used as outcomes and mediators in analytic models.

We plan to include selected student-level variables as covariates in our analytic models (e.g., student background characteristics of gender, race, and ethnicity). School background characteristics such as size, demographic composition, and the school average of eighth-grade state assessment scores in mathematics will be considered to examine contextual effects.

Statistical Analysis Plan: Please see Appendix H11.

Dissemination of Results

Project results will be disseminated through the NMSI and WCA websites, regular conferences and workshops (e.g., CCSSO, AERA, peer-reviewed publications, and in focused briefings to participating schools in collaboration with NMSI's continuous improvement process.

CONCLUSION

Building on our historical success in stewarding federal funds to drive proven outcomes for all students, NMSI is well positioned to launch and scale Rural ACCESS to transform STEM and computer science opportunities for rural students, thereby shifting academic and career trajectories for a previously underserved population and supporting our nation's economic competitiveness.

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