The National Math & Science Initiative's Partnership to Increase Student Achievement and College-Readiness in STEM Education

Investing in Innovation Fund Grant Application

August 2, 2011

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COMPETITIVE PREFERENCE PRIORITIES

The Advanced Placement Training and Incentive Program (APTIP), as implemented and managed by the National Math & Science Initiative (NMSI), uses the College Board Advanced Placement (AP)[1] curriculum and exam as a tool to expand access to rigorous and engaging coursework in math and science, especially for students traditionally underrepresented in those courses. By increasing the number and diversity of students taking and passing AP courses and exams in those subjects, APTIP increases student achievement and college-readiness.

Competitive Preference Priority 7--Innovations that Support College Access & Success

1. NMSI's APTIP Increases Students' Preparedness & Expectations for College

Research shows that passing AP exams positively impacts college matriculation and graduation.[2] These studies find that an AP course that culminates in an AP exam grade of 3 or higher has a significant, positive impact on a student's likelihood of college success among academically comparable students. This is especially true for low-income, African-American, and Hispanic students, as indicated by **5-year college graduation rates** relative to AP courses:

Student Group	Passing AP Exam	AP Exam Grade of 1, 2	Took AP Course only
African-American	28% higher	22% higher	16% higher
Hispanic	28% higher	12% higher	10% higher
White	33% higher	22% higher	20% higher
Low-Income	26% higher	17% higher	12% higher
Not Low-Income	34% higher	23% higher	19% higher

Additionally, AP students who received credit for introductory college-level math and

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

[2] Geiser, Saul & Santelices, Veronica, "The Role of Advanced Placement and Honors Courses in College Admissions." 2004. Research & Occasional Paper Series No. CSHE 4.04). University of California, Berkeley. Web. <http://cshe.berkeley.edu/publications/docs/ ROP.Geiser.4.04. pdf>; and Dougherty, C., Mellor, L., Jian, S. "The Relationship Between Advanced Placement and College Graduation." February 2006. National Center for Educational Accountability: 2005 NCEA Study Series, Report 1. Web. 4 May 2010. <http://www.nc4ea.org/files/ relationship_between_ap_and_college_graduation_02-09-06.pdf>.

science courses earned the same or higher grades in the second-level college courses as students who took the introductory course in college.[3] Similarly, students who take AP courses have a much lower rate of remediation (28.04% compared to 64.2%).[4] Finally, a recent study shows that African-American and Hispanic students who were exposed to **APTIP in particular** were 69% and 83% more likely, respectively, to graduate from a four-year university than students who were not.[5] Thus, a high-quality AP course in high school fortifies students for a successful transition into and graduation from college. NMSI's APTIP does that by producing statistically significant increases in students who pass AP math, science, and English exams.[6]

2. NMSI's APTIP Helps Students Understand College Affordability, Financial Aid, & the College Application Process

Addressing college affordability, including financial aid, and the college application process is imbedded in APTIP. Participating schools host parent nights that specifically address these issues with presentations on how AP makes college more affordable and discussions on the financial aid and college application processes. Many schools coordinate these APTIP parent nights with college nights where college representatives address these topics as well.

3. APTIP Provides Support to Students from Peers & Knowledgeable Adults

APTIP provides peer-to-peer support that creates a culture of college-readiness beginning in middle school. High school students with high visibility who are taking AP courses, such as

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[3] Morgan, R. and Ramist, L. "Advanced Placement Students in College: An Investigation of Course Grades at 21 Colleges." ETS Statistical Report NO. 98-13. 1998. Web. 8 May 2010. <http://www.collegeboard.com/ap/pdf/sr-98-13.pdf>

[4] Gibson, Neal. "Advanced Placement and First Year Outcomes." The Arkansas Research Center. June 22, 2011. April 2011.

[5] Jackson, C.K. "A stitch in time: The effects of a novel incentive-based high school." Unpublished paper submitted for publication. Chicago, IL: Northwestern University, 2010. <http://www.nber.org/papers/w15722>

[6] Holtzman, Deborah. J. The Advanced Placement Teacher Training Incentive Program (APTIP): Estimating the Impact of an Incentive and Training Program on Students." Unpublished, American Insts. For Research, D.C., 2010.

football players, cheerleaders, and school leaders, talk with younger students about the benefits of AP and encourage those middle school students to expect nothing less than college success. In addition, Saturday student study sessions in high school are also designed to encourage student support and confidence as they bring together students from multiple schools. When high-need students sit next to other students during these sessions, they realize that they know just as much as their peers from other schools, that AP brought them equality of intellect.

Teachers also provide support and knowledge to APTIP students: Saturday study sessions are led by the most knowledgeable AP teachers in the area, state, and country; AP teachers in the classroom provide significant tutoring outside of class time, at least 40 hours per course; and each teacher is mentored and monitored year-round to ensure that they provide the exceptional support and encouragement that creates a culture of college-readiness for all students.

Competitive Preference Priority 9--Improving Productivity

APTIP takes advantage of the AP curriculum and accompanying exams to bring about adjustments in school policies in order to recapture lost impact and increase the productivity of the school's rigorous course offerings and the teachers of those classes. While it may seem ancillary to improving student achievement, the required amendments to school policies open doors for students to access rigorous math and science courses, which is why these revisions are part of APTIP's comprehensive strategy to increase student achievement and college-readiness in math and science, especially for students who are typically underrepresented in those subjects.

First, APTIP requires that schools refine their scheduling and course admittance policies in order to increase access to AP math, science, and English courses. Specifically, APTIP requires that schools amend schedules to avoid conflicts between AP courses that students would likely take at the same time. For example, instead of offering AP AB Calculus at the same time as AP

Biology, because students could take both classes in the same year, the school would be encouraged to offer AP AB Calculus during the same class time as AP BC Calculus, which students could not take during the same year. This slight modification of school schedules can have an impressive impact on the number of AP classes that students take during high school. Not only does it improve the organization of the scheduling system, it increases the efficiency of the qualified staff, as they are able to reach more students.

In addition, APTIP's comprehensive program requirements include a supplement to school-wide compensation plans: financial incentives to students, teachers, and administrators based on the number of students who pass AP exams in math, science, and English. Offering incentives for performance and extra pay for extra work sends a message to students, teachers, and administrators alike that success in rigorous courses is valued. In recognition of the fact that teachers take a risk by teaching more rigorous courses with students who traditionally have not been represented in AP classes, especially in AP math and science, incentives also reward teachers for their dedication to increasing student achievement and encourage them to participate in the professional development necessary to teach to a broader array of students. When used as an element of the larger APTIP program scheme, incentives significantly increase the efficiency and efficacy of (1) the pay structure for teachers and administrators by aligning their goals with students' academic ambitions and (2) the teachers' time spent in professional development by enhancing their ability to teach to a larger group of students, including diverse learners and student groups that are typically underrepresented in math and science. Both of these outcomes improve school-wide productivity while promoting improved student learning.

The extra support provided to students in APTIP is also designed with increased productivity and efficiency in mind. Students in APTIP attend three, six-hour study sessions (per AP course)

that are taught by expert AP teachers in each subject. These sessions ensure that students receive the extra time and tutoring they need to succeed, and APTIP teachers attend the sessions as well so they can follow up with students appropriately. Yet these study sessions serve a dual purpose. While designed, in large part, for student improvement, they also increase teacher productivity by providing professional development for APTIP teachers. As APTIP teachers observe expert AP teachers with their own students studying the same coursework, the APTIP teachers receive very targeted professional development tailored to their particular class and students. The APTIP teachers take the strategies they saw employed during the study sessions back to their own classrooms in order to improve student achievement. In this way, the study sessions increase efficiency by addressing two issues at once: teacher productivity and student improvement.

Finally, APTIP increases teacher productivity by requiring schools to create vertical teaching teams. Each vertical team is arranged by subject and is composed of teachers of that subject from 6th grade through high school and a Lead Teacher who serves as a guide and mentor for the group. This structure creates a forum for communication among teachers so that those instructors understand the building blocks that students must master at each grade level if they are to succeed in the rigorous coursework that is offered in high school. Not only does this increase the efficiency of each teacher's year-long lesson plan by ensuring that it coordinates with students' longer-term learning trajectory, it also lays the groundwork for improved student achievement in each grade and in the advanced coursework offered in high school.

Increasing productivity from a structural perspective (class schedules and AP admittance policies) and at the staff level (vertical teaming, study sessions, and incentives) allows APTIP schools to maximize existing resources to improve student achievement and college-readiness in math and science, especially for students traditionally underrepresented in those subjects.

I. NEED FOR THE PROJECT

1. APTIP – An Exceptional Approach to Promoting STEM Education

The National Math and Science Initiative (NMSI) is a national non-profit that has cultivated an expertise in replicating math and science programs that have a demonstrated impact on improving student achievement in order to address the crisis in science, technology, engineering, and math (STEM) education facing our country. NMSI's Advanced Placement Training and Incentive Program (APTIP) is one such program. APTIP empowers high-need students to succeed in rigorous math, science, and English courses, thereby elevating participating schools' expectations for their students and transforming schools' cultures into ones of college-readiness. APTIP improves educational attainment for high school students, especially students traditionally underrepresented in STEM subjects, by significantly enhancing the high school curriculum and increasing the number and diversity of students taking College Board Advanced Placement (AP) courses and passing AP exams in math, science, and English.

APTIP is a unique program that dares to tackle the STEM crisis at the high school level, when many mistakenly believe a student's academic path is already destined. APTIP proves that even high school students who may not fit the stereotypical AP mold can become prepared for postsecondary courses in STEM. As summarized in the Logic Model (attached at Appendix J, Exhibit 1), APTIP offers incentives to provide motivation for students and their families to take on these challenging courses while also supporting students and teachers with intensive teacher training, teacher and student support, vertical teaming, open and encouraged enrollment in AP courses, financial incentives based on academic achievement, specific and individualized annual achievement goals, and robust data collection to ensure accountability at all levels. APTIP gives students and teachers the tools they need to meet their own high expectations.

This proposal addresses Absolute Priority 2 (Promoting STEM Education) with the **objective of** increasing the number of students passing AP exams in math, science, and English, which requires a score of 3 or higher, in order to increase student achievement[7] and college-readiness in STEM subjects. **APTIP accomplishes this objective** by: making rigorous STEM courses more accessible to high-need students and those traditionally underrepresented in STEM; establishing an expectation that these students can succeed at that level; and supporting students and teachers who aim for those high standards. APTIP's track record reveals that even students who are not at the top of the class can (and want to!) rise to the challenge of advanced courses. **Independent research confirms**, based on past APTIP replication, that **expected outcomes of the proposal** are: (1) significantly increased numbers and diversity of students taking and passing AP math, science, and English exams, including high-need students and those traditionally underrepresented in STEM and (2) increased college enrollment and persistence, especially for high-need students and those traditionally underrepresented in STEM.[8] This project is intended to validate APTIP by conducting a rigorous study of its implementation and effects.

2. Magnitude of the Need for the Services Provided

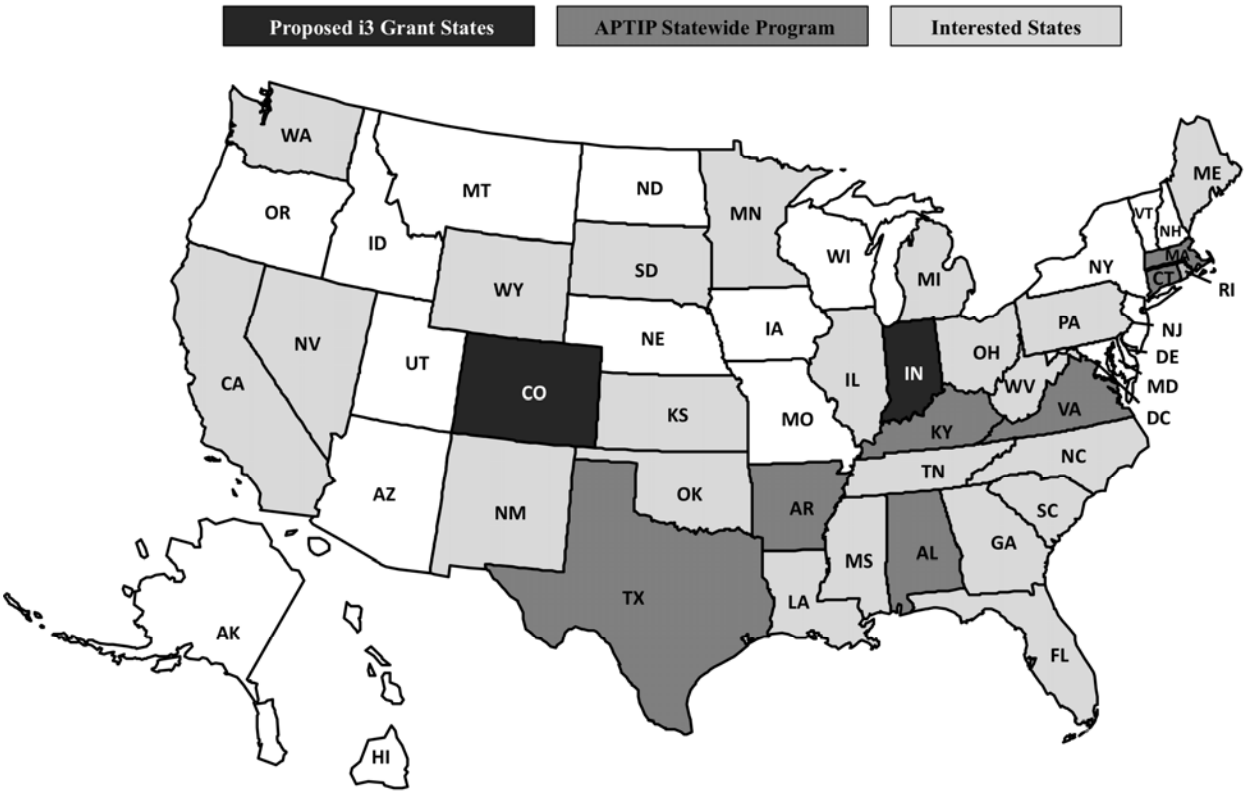
a. Need and Demand for APTIP

In 2007, non-profits from 28 states applied to NMSI's Request for Proposal to replicate APTIP. NMSI selected non-profit partners in six states (Alabama, Arkansas, Connecticut,

[7] According to the Notice Inviting Applications, Student Achievement can be defined to include measures of student achievement that are "rigorous and comparable across classrooms." This application measures Student Achievement by the rigorous, nationally standardized College Board Advanced Placement examination.

[8] Holtzman, D.J. "The Advanced Placement Teacher Training Incentive Program (APTIP): Estimating the impact of an incentive and training program on students." Educational Evaluation and Policy Analysis. Unpublished, American Insts. For Research, DC , 2010.; Jackson, C.K. "A stitch in time: The effects of a novel incentive-based high school." Unpublished paper submitted for publication. Chicago, IL: Northwestern University, 2010. <http://www.nber.org/papers/w15722>; see also Section I.4.a below.

Kentucky, Massachusetts, and Virginia) to scale APTIP. NMSI seeks $14,996,367 in funding for this proposed i3 Validation Grant to continue meeting the existing national demand for APTIP by scaling it further, to reach **90,900 additional students** in 180 high schools and feeder middle schools. NMSI will do so by replicating APTIP in Colorado and Indiana by partnering with 40 LEAs, the Colorado Legacy Foundation, and the University of Notre Dame to establish an infrastructure that will support continued expansion in each state after the grant period. See Appendix C, Exhibit 2 for a list of the 40 LEA partners.



b. Need to Increase Student Achievement and College-Readiness in STEM

In addition to a well-documented need to increase high school student achievement and college-readiness,[9] the U.S. also faces an acute need for increased achievement in math and

[9] McKinsey & Company. "The Economic Impact of the Achievement Gap in American Schools." April 2009. Web. 4 May 2010. <http://www.mckinsey.com/App_Media/Images/

science. The World Economic Forum ranks the United States 48th in quality of math and science education.[10] This comes as no surprise given the results of numerous national and international math and science exams. For example, the 2009 National Assessment of Educational Progress (NAEP) science results indicate that student performance in science education declines as students get older.[11] From a global perspective, U.S. students performed below average on the PISA exam, which compares the performance of U.S. 15-year-olds in reading, math, and science literacy against their peers internationally.[12] U.S. Secretary of Education Arne Duncan recently expressed his concern that the "PISA results, to be brutally honest, show that a host of developed nations are out-educating us... Americans need to wake up to this educational reality."[13]

This international gap in STEM education plays out at the state level in the form of a college-readiness gap that disproportionately affects African-American and Hispanic students, as shown, in part, by their underrepresentation in taking and passing AP exams. For every 1,000 African-American and Hispanic Juniors and Seniors in the U.S., there are *only 32.8 AP math, science, and English exams passed*, compared to 116.0 exams passed for every 1,000 Juniors and Seniors of all ethnicities nationally. These numbers are even more pronounced in Colorado and Indiana. The following represents the number of exams passed by African-American and Hispanic Juniors and Seniors for every 1,000 in each state, compared to the number of exams passed by all Juniors and Seniors for every 1,000 in each state: **CO** – 33.4 v. 148.0; **IN** – 20.5 v. 81.1. The

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Page_Images/Offices/SocialSector/PDF/achievement_gap_report.pdf>; Dougherty, 14 (noting "a major college preparation gap for low-income students).

[10] World Economic Forum, *The Global Competitiveness Report 2009-2010*. <http://www.weforum.org/pdf/GCR09/Report/Countries/United%20States.pdf>

[11] <http://nationsreportcard.gov/science_2009/>

[12] *PISA 2009 Results: What Students Know and Can Do – Student Performance in Reading, Mathematics and Science*. (Volume I) (OECD, 2010).

[13] Robelen, Eric. Education Week, *U.S. Rises to International Average in Science*, Vol. 30, Issue 15. Published online Dec. 7, 2010. <http://www.edweek.org/ew/articles/2010/12/07/15pisa.h30.html>

need for increased college-readiness in STEM subjects in Colorado and Indiana is undeniable.

Yet, there is hope. A recent study published by the Harvard Education Press suggests that AP math and science courses and exams have a positive academic impact.[14] Taking into account control variables like gender, ethnicity, parental education level and socioeconomic status, the research indicates that students who took AP math or science exams were more likely than non-AP students to earn degrees in physical science, engineering, and life science disciplines. These majors prepare students for growing workforce demands in STEM fields.

NMSI's APTIP addresses this need to increase student achievement in AP math and science courses, especially for high-need students. The student populations of the LEAs partnering with NMSI in this application have a higher percentage of typically high-need student groups than the state average. While the two states' total high schools' average student population is 24.4% African-American and Hispanic and 34.3% economically disadvantaged, the application schools' average is 36.5% African-American and Hispanic and 41.8% economically disadvantaged. Moreover, even though the schools in these states are, on average, 36.5% African-American and Hispanic, only 7.6% of the passing math, science, and English AP scores were earned by African-American and Hispanic students. If awarded, this grant's positive impact would disproportionately reach high-need students.

3. Why AP?

APTIP focuses on the AP curriculum because its benefits are relatively unique among high school courses: it is a **rigorous curriculum** that provides a **common metric of evaluation**

[14] Tai, R.H., Liu, C.Q., Almarode, J.T., and Fan, X. "Advanced Placement Course Enrollment and Long-Range Educational Outcomes." In *AP: A Critical Examination of the Advanced Placement Program*, eds. Philip M. Sadler, Gerhard Sonnert, Robert H. Tai, and Kristin Klopfenstein, Harvard Education Press, 2010.

across all 50 states. As a common assessment tool of college-ready standards,[15] AP provides the structure necessary to bring high standards to national scale with efficiency and accountability for results that can be shown nationwide.

Some critics of AP suggest that the curriculum design and supporting pedagogy are not the best approach to producing student learning, especially for diverse students.[16] While this criticism may be true if AP classes are taught in the traditional college lecture style, it does not apply to APTIP. NMSI is mindful of the efficacy of teaching approaches that use active student engagement, hands-on demonstration and experimentation, and challenging problem-solving and analysis. These approaches are ingrained and emphasized in APTIP's teacher training and course curriculum. Therefore, although the AP courses may reflect traditional, entry-level college courses in content, APTIP uses pedagogical approaches designed to maximize achievement among broad and diverse groups of secondary students.

NMSI identified APTIP as an effective program that uses AP courses and exams as a tool to help address the national STEM education crisis when it was recommended by the National Academies in the landmark report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. APTIP was implemented in 1996 in 10 schools in the Dallas Independent School District, the nation's 12th largest school district with a 86% free and reduced lunch enrollment rate. The demonstrated success of that pilot initially led to APTIP's replication in 26 LEAs in Texas with success in 92 schools of all sizes,

[15] NMSI recognizes that states are currently developing state-led common standards and assessments that will also provide a common metric. But it will take significant time until they are fully implemented such that data can be collected and tracked nationally. In the meantime, the AP exam provides rigorous assessments that allow national data collection and analysis.

[16] See Wood, William, B. "Revising the AP Biology Curriculum." Science 25. September 2009: 1627-1628.

demographics, and locations, and is the source of the current successful replication of APTIP across 320 schools in 216 school districts.

4. Importance and Magnitude of Effect Expected to be Obtained

NMSI's results to date demonstrate that APTIP **rapidly improves student performance in math and science, especially for high-need students and those traditionally underrepresented in STEM fields.** Since just 2008, APTIP has trained over 6,000 existing AP and Pre-AP teachers in curriculum development, effective pedagogy, and specialized content knowledge and opened access for over 27,000 students to become prepared for postsecondary study in STEM by passing AP math, science, and English exams.

APTIP produced significant improvement that can be easily replicated in a variety of settings and for a variety of students. Over a two-year period, the first cohort of 63 schools recorded a 102% increase in passing math, science, and English scores (from 584 passing to 1,178 passing) among low-income students. The same 63 schools recorded a 154.6% increase in passing math, science, and English scores in two years among African-American and Hispanic students, which is almost six times the national two-year increase of 27.7%. Those schools also recorded a 116.4% increase in passing math and science scores in two years among female students, which is almost 13 times the national two-year increase of 9.2%. APTIP results are also positive across a variety of school settings. In addition to obtaining positive outcomes in states as diverse as Alabama and Massachusetts or Kentucky and Connecticut, APTIP is also increasing passing AP scores in both urban and rural contexts. In the 2009-2010 school year, NMSI's 38 urban APTIP schools had a 43% increase in passing math and science exams, while the 37 rural APTIP schools had a 66% increase. These outcomes, respectively, are 6 and 9 times the national increase of 7.5% for all schools.

Given the need for increased access to and success in STEM subjects in Colorado and Indiana described in Section I.2.b above, expanding this impact to those states is critical.

a. Extent to Which the Project will Fulfill i3's Purpose

Research indicates that APTIP increases student achievement and college-readiness by increasing access to rigorous and engaging coursework in STEM, especially for high-need students and those traditionally underrepresented in STEM, such as minorities and women. Two recent studies examined the impact of APTIP, and both found positive effects (studies attached at Appendix D). The first study (Jackson 2007)[17] had a follow up component (Jackson 2010)[18] with a broader set of outcomes that analyzed data from the Advanced Placement Incentive Program (APIP). APIP has been implemented in Texas since 1990, and NMSI now replicates it in six states (renamed APTIP). Since APIP and APTIP are the same program—the same Elements of Success and replication strategies are applied in both—the findings from these Jackson studies apply to NMSI's APTIP. The second study analyzed data from NMSI's APTIP implementation.

i. The Jackson Studies of APIP

Jackson's (2007) first study found that **APIP produced significant increases in AP course enrollment, SAT/ACT scores, and college matriculation, and that these effects continued to increase over time**.[19] The study examined cohorts within and across APIP schools and included 1,438 schools in Texas from 1994-2005. To measure changes in AP course enrollment, Jackson (2007) compared AP enrollment to non-AP course enrollment in program schools and found that enrollment increased by 6% after the first year of APIP, 12% after the second year, and 21% in

[17] Jackson, C. Kirabo. 2010. "A Little Now for a Lot Later: A Look at a Texas Advanced Placement Incentive Program." Journal of Human Resources 45(3): 591–639. <http://jhr.uwpress.org/cgi/content/abstract/45/3/591>

[18] Jackson, "A Stitch in Time."

[19] Jackson, "A Little Now."

subsequent years. To measure differences in SAT/ACT scores and college matriculation, comparisons of APIP schools to non-APIP schools were conducted and found that the number of APIP students scoring above 1100/24 on the SAT/ACT increased each year, by 19% after the first year of APIP, 22% after the second year, and 33% after the third year. In addition to significant positive effects on average student outcomes, Jackson (2007) notably found that APIP had similarly positive effects for African-American and Hispanic students taking AP exams and scoring above 1100/24 on the SAT/ACT.

Jackson's (2010) research clearly indicates that APIP's benefits also extended beyond high school to **college enrollment, which increased by about 8%** for APIP students in comparison to non-APIP students. Moreover, Jackson's (2010) second study found that the positive effects of the program endured through college. Using the same sample of students from APIP and non-APIP comparison schools, Jackson (2010) examined longer-term effects of APIP. The results demonstrate that the ***increases in student achievement caused by APIP persist into college*** with particularly positive effects on college outcomes for African-American and Hispanic students.[20] Not only did APIP increase college matriculation relative to non-APIP students, APIP students also performed better as college freshman, with average GPAs 0.09 points higher than non-APIP students. Additionally, 22% more APIP students persisted in college than non-APIP students,[21] indicating APIP improved the overall educational attainment of participating students.

The study found that the benefits of APIP for African-American and Hispanic students were even more significant. **African-American and Hispanic students who participated in APIP**

[20] Jackson, "A Stitch in Time" 27-28.

[21] Jackson classified college persistence as persisting to the sophomore year, since the majority of college attrition occurs in the freshman year.

were more likely to graduate from a four-year college than non-APIP students.[22] This likelihood increased with each year that schools participated in APIP. By the fourth year, African-American and Hispanic students were 2.5% and 2.7%, respectively, more likely to graduate from a four-year college than non-APIP students. This represents increases in graduation rates of **69% for African-American students and 83% for Hispanic students**.[23]

ii. The Holtzman Study of APTIP

Holtzman[24] focused on the APTIP program as currently implemented in six states. This study found that **APTIP significantly increases student achievement**, including the percentages of students taking AP exams and scoring 3 or higher on AP exams. This study used a comparative interrupted time series design (CITS) to compare 64 schools in the six states that implemented APTIP in 2008-09 with 128 non-APTIP schools matched on prior performance. The 128 selected comparison schools closely resembled the 64 APTIP schools on every one of the 10 outcomes of interest in all three pre-implementation years: 2006, 2007, and 2008.

Holtzman used the CITS analysis to study the impact of APTIP on each of the 10 outcomes. This method, one of the strongest quasi-experimental designs available, statistically analyzes the post-implementation outcomes of the treatment schools in relation both to their own performance prior to implementation and to the performance of comparison schools that never implemented APTIP.

In all of the subject areas/combinations, results show that **implementation of APTIP is associated with large, statistically significant increases in the percentages of students taking AP exams**. For example, implementation of APTIP was associated with a 12-point increase—

[22] Jackson, "A Stitch in Time" 28.
[23] *Id.*
[24] *Supra*, note 8.

more than a full standard deviation—in the percentage of students taking at least one math, science, or English AP exam.[25] The percentage increases associated with APTIP implementation for taking at least one exam in math, science, and English (MSE), individually, were 3 points, 6 points, and 9 points, respectively.[26] The latter two, again, represented increases of more than a full standard deviation.

The results for MSE AP exam-taking are shown in Figure 1. The sharp uptick of the APTIP schools to the right of the vertical line, which represents the time of APTIP implementation, indicates the positive effect of the program on this outcome. A similar, statistically significant pattern was also observed for AP exam taking in each subject individually and for all AP exams.

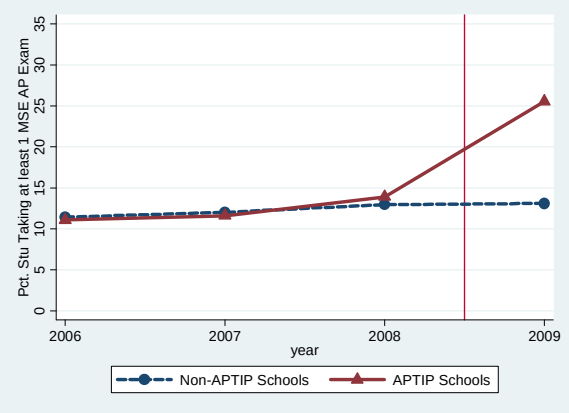

Figure 1: Percentage Taking Math, Science, or English AP Exams, APTIP Average (n=64) vs. non-APTIP Average (n=128)

Holtzman also found **strong, statistically significant positive impacts of APTIP on AP exam passing** (scoring a 3 or higher). The percentage point differences due to APTIP were 0.7 for math, 0.9 for science, 2.4 for English, and 3.0 for all three subject areas combined. For the latter two, these results translate to effect sizes of approximately 0.5 (half a standard deviation[27]). These results are notable because, while the effects on exam-taking clearly indicate that more students take AP exams in APTIP schools than in non-APTIP schools, it is also true that exam passing rates increase as well, despite the broader array of students taking the exams.

[25] *Id.* 13.
[26] *Id.*, Table 6.
[27] Calculated based on the pooled standard deviation for the sample of 192 schools that includes the APTIP schools and all of the potential matched comparison schools in Spring 2008 (the year prior to APTIP implementation).

Additional analyses also suggested that the increases in the percentages of students passing were partly due to the increased percentages taking the exams. Taken together, these results suggest the possibility that, while access is expanded by APTIP, APTIP also offers support to help an expanded pool of students succeed. Figure 2 shows the results on MSE exam-passing.

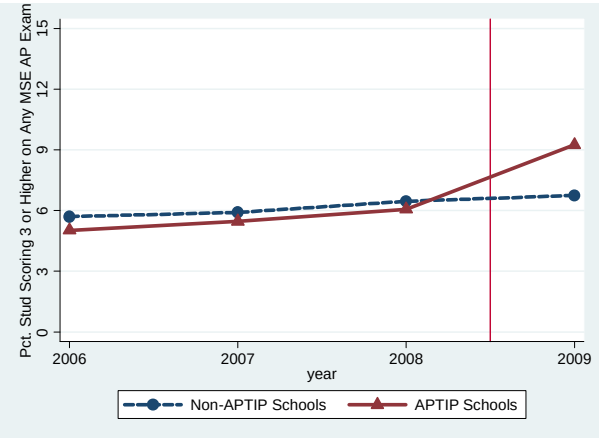

Figure 2: Percentages Scoring 3 or Higher on MSE AP Exams, APTIP Average (n=64) vs. non-APTIP Average (n=128)

In sum, Holtzman demonstrates ***APTIP's substantial and statistically significant effects on AP-related outcomes***. Taken together, the results of the Holtzman and Jackson studies suggest that **the project proposed in this application is expected to have significant effects for students on average and particularly for high-need students and those traditionally underrepresented in STEM subjects**.

II. QUALITY OF THE PROJECT DESIGN

1. Actions Aligned with Absolute Priority 2: Promoting STEM Education

a. APTIP: An Approach Based on Up-to-Date Knowledge from Research and Effective Practices

APTIP challenges existing assumptions about who is capable of high achievement by creating school environments where *all* students are seen as capable of succeeding in rigorous courses. The Logic Model of APTIP (see Appendix J, Exhibit 1) is grounded in a theoretical framework that views schools as critical places where social order issues can either advance or inhibit students' access to the best of what a democratic society has to offer.[28] APTIP

[28] Dewey, J. Democracy and education: An introduction into the philosophy of education. New York: Simon & Schuster, 1916/1944; Boyles, D., Carusi, T. & Attick, D. "Historical and

implements this theory by providing significant student support, in-depth teacher training and support, financial incentives for teachers, students, and administrators, and strong program management. Specific APTIP components address school-wide expectations, the social context for learning, articulated curriculum, teacher community, motivation to change and to learn, and teacher content knowledge. The program management plan incorporates elements of High Reliability Schooling[29] that have been shown in rigorous studies to improve both the reliability of implementation of school-wide reforms at the secondary level *and* the sustainability of those reforms after withdrawal of external supports.[30]

i. APTIP Elements of Success

APTIP's Logic Model and the supporting strategies address the needs identified for a more rigorous STEM curriculum that AP courses in math, science, and English provide and for a corresponding increase in student participation, achievement, and college-readiness, especially for students traditionally underrepresented in STEM. Through the Logic Model, NMSI has identified the key factors of APTIP that are indispensible to implementing the program with fidelity to the original model. These Elements of Success (see figure, below) are the foundation for successfully implementing APTIP, and, as such, NMSI requires strict adherence to each.

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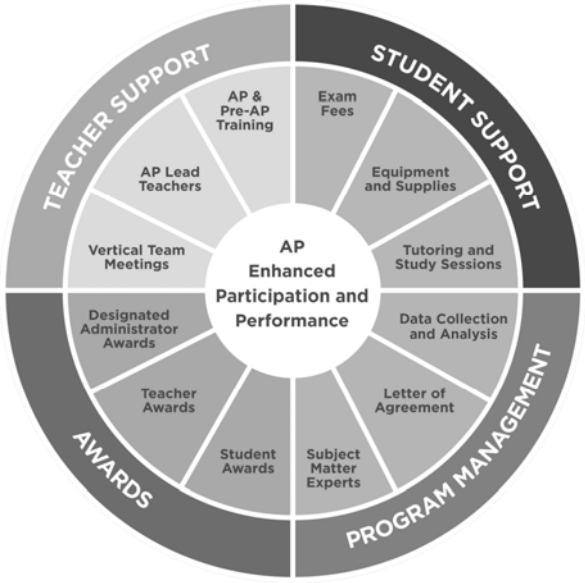
critical interpretations of social justice." In W. Ayers, T. Quinn & D. Stovall (eds.), Handbook of Social Justice in Education. New York: Routledge, 2009.

[29] Bellamy, T.G., Crawford, L., & Marshall, L.H. "The fail-safe schools challenge: Leadership possibilities from high reliability organizations." Educational Administration Quarterly, 41, 2005: 383-412; Marzano, R.J., & Waters, T. District leadership that works: Striking the right balance. Bloomington, IN: Solution Tree Press, 2009; Stringfield, S. "Attempting to enhance students' learning through innovative programs: The case for schools evolving into high reliability organizations." School Effectiveness and School Improvement, 6, 1995: 67-96.

[30] Stringfield, S., Reynolds, D., Schaffer, E.C. "Improving secondary students' academic achievement through a focus on reform reliability: 4- and 9-year findings from the High Reliability Schools project." School Effectiveness and School Improvement, 19(4), 2008: 409-428.

1. Program Management



NMSI manages APTIP implementation through comprehensive, standardized fiscal and program management systems that provide a structured mechanism for APTIP replication. First, NMSI partners with non-profits in each state (NMSI State Agents, or NSAs) who manage APTIP's day-to-day activities and act as NMSI's agent with the LEAs and schools. NSA partners for this proposal are the Colorado Legacy Foundation and the University of Notre Dame. Their core management responsibilities include:

Assessment, Setting Goals, Planning: NMSI and the NSAs conduct a thorough, initial assessment of the current AP environment at participating schools, establish performance goals, and set plans for meeting those goals, including ensuring that the teachers are dedicated to APTIP, and evaluating and recommending appropriate amendments to school policies (such as scheduling and course admittance policies) in order to maximize success.

Letter of Agreement: Each LEA and school signs a formal Letter of Agreement that describes the responsibilities of APTIP implementation to clearly define expectations.

Ongoing operational aid includes overseeing day-to-day implementation, monitoring APTIP according to NMSI's operational milestones, and providing direct assistance to the schools.

Policy support requires championing policies that promote NMSI's over-arching goal of improving access to quality education for all students, improving student achievement and student growth for all students, and closing the college-readiness gap. It also includes working

with state and local governments to promote quality education by, in part, sustaining and incorporating APTIP into the state's education policy.

Data Collection. NMSI insists on detailed, student-level data collection so that APTIP can not only measure and report outcomes, but also evolve and improve based on feedback from each LEA. (See Section IV.1.b for the complete data collection, management, and analysis plan).

2. Student Support: Encouraged Enrollment & Extra Time on Task

Students accept the expectations adults have or do not have regarding their ability to perform academically, and they respond accordingly.[31] The culture fostered at APTIP schools recognizes that students can often achieve well beyond traditional expectations. While some schools restrict access to challenging courses, these policies erroneously reinforce flawed stereotypes about the characteristics of AP students. In contrast, the types of equitable practices emphasized at APTIP schools are closely related to those factors that produce good learning environments for racially and linguistically diverse students.[32] APTIP schools are required to establish an inclusive environment that encourages students to enroll in rigorous courses. Additional time in content-based social contexts for academic learning also supports a range of students in the development of the cognitive tools necessary for advanced study in a discipline.[33] The APTIP model provides students with after-school tutoring, at a minimum of 40 hours per teacher per year. APTIP also

[31] Brophy, J. "Research on the self-fulfilling prophecy and teacher expectations." Journal of Educational Psychology, 75, 1983: 631-661; Wineburg, S. "The self-fulfilling prophecy." Educational Researcher, 16, 1987: 28-37.

[32] Datnow, A., Lasky, S.G., Stringfield, S.C., & Teddlie, C. "Systemic integration for educational reform in racially and linguistically diverse contexts: A summary of the evidence." Journal of Education for Students Placed at Risk, 10(4), 2005: 441-453.

[33] Bruner, J. The Culture of Education. Cambridge, MA: Harvard University Press, 1996; Donald, M. Origins of the modern mind: Three stages in the evolution of culture and cognition. Cambridge, MA: Harvard University Press, 1991; Egan, K. The educated mind: How cognitive tools shape our understanding. Chicago: University of Chicago Press, 1997; Lave, J. & Wenger, E. Situated learning: Legitimate peripheral participation. Cambridge University Press, 1991; Vygotsky, L. S. Mind in society. Cambridge, MA: Harvard University Press, 1978.

offers at least three AP extracurricular study sessions per subject, which are led by state and national experts. These sessions almost always combine schools, and this helps students in schools with a high percentage of low-income students to gain confidence as they see that they are just as competent and knowledgeable as students in other schools.

3. Teacher Support: Training, Mentoring, & Vertical Teaming

APTIP insists on training teachers with relevant pedagogical methods and providing continual support of teachers as they adopt these skills through inside-in and outside-in support structures critical to successful implementation of comprehensive reforms.[34] Teachers' pedagogical content knowledge (their knowledge of how best to represent a specific discipline to diverse learners), has been identified as a critical construct for effective teaching.[35] Large-scale research has confirmed that teachers' pedagogical content knowledge impacts student learning and achievement,[36] so teachers participating in APTIP attend training to ensure their content knowledge meets APTIP standards. Additionally, APTIP establishes a collegial community of professionals among teachers. Westheimer[37] (2008) conceptualizes teacher colleagues as a specific context and resource for teacher learning. Such teacher professional communities

[34] Bol, L., Nunnery, J.A., Lowther, D.L., Dietrich, A.P., Pace, J.B., Anderson, R.S., Bassoppo-Moyo, T.C. & Phillipsen, L.C. "Inside-in and outside-in support for restructuring: The effects of internal and external support on change in the New American schools." Education and Urban Society, 30, 1998: 358-384.

[35] McDiarmid, G.W. & Clevenger-Bright, M. "Rethinking teacher capacity." In M. Cochran-Smith, S. Feiman-Nemser, D.J. McIntyre & K.E. Demers (Eds.), Handbook of research on teacher education: Enduring questions and changing contexts (3rd ed.) New York: Routledge, 2008: 134-156; Shulman, L.S. "Knowledge and teaching: Foundations of the new reform." Harvard Educational Review, Feb. 1987: 1-22.

[36] Hill, H., Rowan, B. & Ball, D. "Effects of teachers' mathematical knowledge for teaching on student achievement." American Educational Research Journal, 42(2), 2005: 371-406; McDiarmid & Clevenger-Bright 2008.

[37] Westheimer, J. "Learning among colleagues: Teacher community and the shared enterprise of education." In M. Cochran-Smith, S. Feiman-Nemser, D.J. McIntyre & K.E. Demers (Eds.), Handbook of research on teacher education: Enduring questions and changing contexts (3rd ed.), New York: Routledge, 2008: 757-783.

encourage collaborative exchanges that increase opportunities to improve teaching practices, resulting in measurable gains in student achievement.[38]

APTIP's individual and community teacher support includes: (1) A State Content Director for each discipline who coordinates the subject area's curriculum to ensure consistency across the state; (2) Summer Sessions for Lead Teachers regarding monitoring and mentoring for APTIP; (3) Two content-based training sessions and one workshop to ensure quality and standards for AP Teachers; (4) Vertical Teams in each APTIP subject; (5) Pre-AP training provided by Laying the Foundation; and (6) Continuous monitoring with guidance, feedback, and training by Lead Teachers and State Content Directors.

4. Incentives for Teachers & Students Based on Student Performance

Offering incentives for performance and extra pay for extra work sends a message to students and teachers alike that success in rigorous courses is valued. In recognition of the fact that teachers take a risk by teaching more rigorous courses with students who traditionally have not been represented in AP classes, incentives also reward teachers for their dedication to increasing student achievement and encourage them to participate in the professional development necessary to teach to a broader array of students. Models of motivation suggest that the

[38] Little, J.W. "Organizing schools for teacher learning." In L. Darling-Hammond & G. Sykes (eds.), Teaching as the learning profession: Handbook of policy and practice. San Francisco: Jossey-Bass, 1999: 233-262; Louis, K.S. & Marks, H.M. "Does professional community affect the classroom? Teachers' work and student experiences in restructuring schools." American Journal of Education, 106, 1998: 532-575; McLaughlin, M.W. "What matters most in teachers' workplace context." In J. Little & M. McLaughlin (eds.), Teachers' work: Individuals, colleagues, and contexts. New York: Teachers College Press, 1993: 79-203; Newmann, F.M. & Wehlage, G.G. Successful school restructuring: A report to the public and educators by the Center on Organization and Restructuring of Schools. Washington, DC: American Federation of Teachers, 1995; Smylie, M. & Hart, A.W. "School leadership for teacher learning and change: A human and social capital development perspective." In J. Murphy & K.S. Louis (eds.), Handbook of research on educational administration. San Francisco, CA: Jossey-Bass, 2000: 421-441; Westheimer 2008.

likelihood that individuals will engage productively in learning behaviors depends not only on the extent to which they value the rewards associated with a task, but also on the extent to which they expect they can achieve success with a task.[39] APTIP attends to both aspects of the motivational equation by providing incentives to learn, with appropriate structured supports that make achieving success possible.

Importantly, in prior research, concerns that incentive-based interventions might lead to "teaching-to-the-test" and cheating were not realized, while the benefits of the APTIP incentives for student achievement lasted in post-secondary education.[40] APTIP's incentives are, therefore, a means of helping students recognize the importance of and give priority to rigorous education. Incentives offered through APTIP are generally $100 to each student who passes an AP math, science, or English exam and $100 to each teacher for each student who appears on their roster and passes the AP exam. Teachers and administrators also receive larger bonuses of $1,000 based on pre-determined thresholds of students who pass AP exams in their class/at their school.

These four strategies are the backbone of APTIP's Logic Model and implementation structure. The unique combination of financial incentives, teacher training, student support, and structured program management creates a program that not only encourages teachers to believe in their students and students to take a risk in believing in themselves, it also provides the concrete tools and techniques to both teachers and students to make improved high school STEM education a reality. The provision of highly articulated and concrete materials and strategies have proven to be essential for scale-up of educational reforms.[41] In contrast to programs that require

[39] Feather, N. (Ed.). Expectations and actions. Hillsdale, NJ: Erlbaum, 1982.
[40] Jackson "A little now" and "A stitch in time."
[41] Nunnery, J.A., Bol, L., Dietrich, A., Rich, L., Kelly, S., Hacker, D., & Sterbin, A. "Teachers' initial reactions to their pre-implementation preparation and early restructuring experiences." School effectiveness and school improvement, 8, 1997: 72-94; Nunnery, J.

years of implementation to bring out results, APTIP challenges the *status quo* and produces significant improvements in learning within the first year.

b. NMSI's APTIP Replication Structure

NMSI, the Scaling Coordinator: As a national entity and scaling entrepreneur, NMSI is well-positioned to guide immediate, expanded adoption of APTIP while ensuring fidelity to APTIP's Logic Model and also allowing creativity and collaboration with schools and LEA partners. NMSI uses products and services that have proven successful in the current six replication states and that provide a framework for implementation, replication support, performance management, and quality control. See Section IV below for a full description of NMSI's management services.

NMSI's scaling strategy includes structured replication and implementation methods. NMSI will phase in APTIP implementation by scaling APTIP in annual cohorts of 20 high schools in 2012-2013, 2013-2014, and 2014-2015. Each cohort will receive guidance and support from NMSI and the NSA for a full three-year period, with the expectation that the schools will be self-sustaining afterwards. Phasing in cohorts over time allows the scaling partners to master APTIP implementation with a manageable number of schools in the beginning and then use that capacity and experience to rapidly expand throughout the state or network of schools. As scaling progresses, each school requires less direct support, and economies of scale develop.

Increasing Student Achievement, the School District Partners: The LEA is a critical partner that is responsible for offering the AP courses and teachers and for cultivating the environment of rigorous expectations and a culture of opportunity for college-readiness. Most importantly, the LEA takes ownership and pride in this venture to improve student achievement. LEAs provide:

"Reform ideology and the locus of development problem in educational restructuring: Enduring lessons from studies of educational innovation." Education and Urban Society, 30(3), 1998: 277–295.

substitute teachers when AP teachers attend training; fees for all 10th graders' PSAT exams or equivalent; Lead Teachers' release time; and equipment match. Within the school districts, there are several crucial positions: Lead Teachers, AP Teachers, pre-AP Teachers, and Principals.

Lead Teachers are outstanding AP math, science, and English teachers (one per discipline) who serve as the hub of APTIP at that school, taking ownership for significantly increasing the number of students who enroll in AP courses and pass AP exams in that subject. The Lead Teacher shares high-quality instructional materials and apprises AP Teachers of opportunities for advanced level, content-focused professional development, while also mentoring AP and Pre-AP Teachers and modeling lessons as necessary. The Lead Teacher also develops a Vertical Team comprised of all AP and pre-AP Teachers at each school in their respective subject areas and facilitates and conducts study sessions for AP students.

AP Teachers are on the front lines of achieving annual increases in the number of students succeeding in AP, and they have specific goals each year for the number of students expected to pass AP exams in their classes. Lead Teachers and other expert NMSI and/or NSA staff monitor and support AP Teachers to help them reach these goals and to ensure their instructional methods meet the rigor and quality required by APTIP. AP Teachers also tutor students during the year.

Pre-AP Teachers are the key to increasing the pipeline of students who enter high school prepared for AP-level coursework. They receive training in adding rigor, student engagement, inquiry-based instruction, and attend Vertical Team meetings to better understand the progression students require in order to meet AP requirements by high school.

Principals set the overall tone for school culture and are an integral part of APTIP success. They take responsibility for significantly increasing the number of students who pass AP exams by amending school policy as necessary to remove barriers to access. Principals also host parent

meetings to generate interest in and awareness of APTIP; they are the community advocates for the program.

c. Actions Expected to Result in Achieving the Project's Goals

The specific actions based on the Logic Model description above that result in APTIP's success are detailed in the 2-page APTIP Strategies and Actions Chart, the 4-page NMSI APTIP Implementation Milestones chart, and the 6-page NMSI Project Milestones chart, which are all attached in Appendix J, Exhibit 2.

2. Reasonableness and Estimate of APTIP Costs: Actual and Estimated at Scale

In this proposed project, NMSI will expand student access to rigorous courses and create opportunities to increase student achievement in STEM, especially for students underrepresented in those subjects, in 180 high schools and feeder middle schools to reach approximately **90,900 students** at a total cost of $16,540,549 (i.e., the direct and indirect costs of the project, including NMSI's 10% match, but excluding the cost of the independent evaluation) (see Budget and Budget Narrative). Both NMSI and the NSAs have capacity and resources to reach these students, as described in Section IV.3.d.

The estimated cost of scaling APTIP is only $182 per student, based on the project cost of $16,540,549. This cost per student is not a "per-year cost," but a one-time cost that provides multiple years of service to all students. In contrast, the annual cost per student is only $93, since the total number of students impacted, if each student is counted each year, is 177,840.

APTIP generates economies of scale as it reaches more students. APTIP costs per student are: $180 to reach 100,000 students; $167 to reach 250,000 students; and $155 to reach 500,000 students. This economy of scale is generated because, in comparison to reaching 100,000 students, NMSI does not require much additional capacity to reach 500,000 students.

3. Potential and Planning to Incorporate APTIP into the Ongoing Work of the Partnership

Scaling achieves its goals best when the model is sustainable. Because NMSI aims to transform schools' underlying cultures, sustainability is built into APTIP's program, financial, and partnership structures as a component that tracks the entire scaling process.

a. APTIP's Multi-Year Financial & Operating Model

First, sustainability is built into APTIP's budget structure. NMSI requires that the NSA raise an increasing percentage of matching funds over the course of the grant period. By decreasing the portion of the budget that is provided by the grant each year and increasing the portion of the budget that is raised by the NSA each year, NMSI helps instill a culture of financial independence that is crucial to avoiding a funding cliff. By the end of the three-year grant period, the NSA has learned how to operate APTIP independent of the initial grant funds, and APTIP is self-sustaining. They may develop strong relationships with corporate or philanthropic donors, apply for federal or state competitive grants, and many will have secured state funding. For example, Alabama's governor announced recently that all $1.3 million in state funds traditionally used in conjunction with AP courses and exams would flow through the NSA operating in Alabama for use in its APTIP schools. The six states currently replicating APTIP have already raised $33.5 million in matching funds, a figure that demonstrates strong support, especially in this economic climate. By requiring the NSA to shoulder an increasing portion of the operating budget each year, NMSI builds APTIP sustainability into the budget structure.

b. Support from Stakeholders Who Are Critical to Long-Term Success

To avoid any surprises regarding the APTIP "hand off" after the funding period, NMSI also conveys the goals of APTIP to state level officials, including the Governor and Commissioner of Education. Both are briefed on the proposed scaling model, matching requirements, and the

expectation that the state will contribute support for APTIP following NMSI's investment. NMSI's replication and scaling model reinforces these expectations by regularly engaging state officials, including state and federal legislators, in APTIP's progress. In addition to receiving updates on ATPIP's accomplishments in their states, these officials are invited to and regularly attend events such as back-to-school kick-offs, celebrations of end-of-year performance, and announcements of new LEA cohorts. These public stakeholders, from Governors and State Departments of Education to legislators, have, in turn, shown remarkable support for APTIP. (See Letters of Support at Appendix G, Exhibit 1).

The private sector also shows strong support. Foundations and corporations in Colorado and Indiana, including The Lumina Foundation, the Daniels Fund, the AMGEN Foundation, the JFM Foundation, and the Lilly Foundation, have already pledged almost half a million dollars towards APTIP's sustainability. By committing funds before APTIP has been implemented, these stakeholders pave the way for incorporation of APTIP into the ongoing work of the LEAs.

III. EVALUATION PLAN

The American Institutes for Research (AIR) will conduct the independent evaluation of APTIP, which will include a study of: (1) program impact on selected student outcomes, and (2) implementation, including the degree of fidelity and factors that may be associated with success.

1. *Evaluation of Program Impact*

The impact evaluation is designed to assess the effects of APTIP on a student outcomes included in the Logic Model (attached at Appendix, J, Exhibit 1) and will be guided by these basic research questions:

1. What is the impact of APTIP on the likelihood that all students in the 11th and 12th grades take and pass AP exams in mathematics, science, and English?

2. What is the impact of introducing APTIP on postsecondary outcomes of high school students, including matriculation and persistence?
3. Are variations in program implementation systematically associated with differences in program outcomes?

a. Design Overview

The evaluation will use a comparative interrupted time series (CITS) design in which outcomes of high schools implementing APTIP in Indiana and Colorado are compared over time to outcomes of other schools selected to be as comparable as possible to the APTIP schools. NMSI has identified 60 high schools in these two states (30 in each) to implement APTIP over three years: 20 in 2012-2013; 20 in 2013-2014; and 20 in 2014-2015. The well-designed quasi-experimental study will generate internally valid evidence on the impact of APTIP in the absence of random assignment by comparing outcomes of schools matched to APTIP schools.

b. Outcome Measures and Data Collection

The primary data for outcome measures will be College Board data for each school in the state that offers AP courses. Outcome measures will include participation in AP courses, taking AP tests, and performance on AP exams as measured by their scores. These outcomes are consistent with the APTIP Logic Model in which program management, teacher support, student support, and incentives increased access to AP math, science, and English courses, enhance instruction, and increase student achievement and college-readiness. Because student-level identifiers are available through College Board data, the evaluation will create unduplicated counts needed to measure course participation, exam taking, and passing outcomes. These will be computed in terms of total share of students in grades 11 and 12 for (1) any AP subject; (2)

math or science fields; or (3) specific course areas (though shares may be small). Outcome data from the College Board will be merged to the Common Core of Data on school characteristics.

As indicated in the Logic Model, APTIP ultimately seeks to increase students' matriculation into and persistence in postsecondary education. As such, AIR will use data from the National Student Clearinghouse, which matches data from postsecondary institutions to student records from individual high schools, when analyzing both treatment and comparison schools. This matching creates reports[42] that show share of students: (1) from a high school class enrolled in college any time within one to two years of graduation or (2) who return after their first year, by institutional type. The Clearinghouse also tracks students to measure retention and graduation. The strength of using Clearinghouse data is that they potentially allow tracking of longer-term outcomes of APTIP such as matriculation and persistence, relative to comparison high schools.[43]

Each district with a school enrolled in APTIP will be expected to provide needed data (names, gender, and graduation dates) to the Clearinghouse. Recruitment of districts that have a comparison school but do not have an APTIP school will be done, in part, by using NMSI's NSA contacts and offering an incentive of $500 a year to provide Clearinghouse data, with AIR providing technical assistance.

c. Sampling Plan

AIR will match comparison schools by selecting public schools within the state comparable to the treatment schools. The match will exclude schools that are expected to adopt APTIP and in which NMSI may be doing preparatory work. Based on the 2008-2009 Common Core of Data, there are approximately 260 secondary schools in Colorado and 310 in Indiana (excluding those

[42] See, e.g., <http://www.studentclearinghouse.org/highschools/pdfs/ST_sample_report.pdf>

[43] Not all students in postsecondary schools can be matched to their high schools, and not all postsecondary students are covered in the data.

adopting APTIP), from which primary school-level outcomes measures related to AP test taking and passing will be calculated, along with postsecondary outcomes.

Matching will be determined using data on three years of prior AP outcomes for each cohort of schools, in addition to characteristics of schools such as demographics (race/ethnicity) and school characteristics such as enrollment and location (rural vs. urban) that will be used in the statistical model as explanatory factors. The evaluation will use a nearest neighbor approach in which APTIP schools are matched to other schools within their state using the Mahalanobis D-measure of distance. The Mahalanobis distance will be computed between each APTIP school and other schools in the state to create a comparison group of schools (60 per state) closest to the individual APTIP schools in terms of this distance. The equivalence of APTIP and comparison schools will be tested by each variable used in the analysis. The power analyses indicate that the impact evaluation will have sufficient power and will be able to detect differences in outcomes between treatment and comparison schools of approximately one percentage point. (See Appendix J, Exhibit 3).

d. Analytic Methods

Given the nested data structure (successive student cohorts nested within schools), a two-level hierarchical linear model (HLM) will be used for the CITS analyses (model at Appendix J, Exhibit 3). APTIP effects for three groups (G1, G2, and G3) of schools (defined in terms of year in which they adopt APTIP) will be estimated for each study year to capture effects over time, both by cohort and also pooled by years after implementation; effects are summarized in Table 1.

Impact Analyses	**Year 1 (2012-13)**	**Year 2 (2013-14)**	**Year 3 (2014-15)**
Effects for individual school groups	G1 one-year effects	G1 two-year effects	G1 three-year effects
		G2 one-year effects	G2 two-year effects
			G3 one-year effects
Effects pooled across multiple		Pooled one-year effects (G1 and G2)	Pooled one-year effects (G1, G2, and

Impact Analyses	Year 1 (2012-13)	Year 2 (2013-14)	Year 3 (2014-15)
school groups			G3)
			Pooled two-year effects (G2 and G3)

Table 1. Impact Analyses, by Study Year

School-level coefficients for APTIP participation in the HLM model will measure the first-year effect of APTIP on (as an example) the percentage of students in 11th and 12th grades who took AP math. Similar HLM models will test the one-year effects for Groups 2 and 3 schools, the two-year effects for Groups 1 and 2 schools, and the three-year effects for Group 1 schools. The basic HLM model will also be modified to test the pooled one-year or two-year effects by adding school group indicator(s) to the school-level model. The impact analyses will be conducted separately for (1) the percentage of students taking AP courses and the percentage passing AP exams in math, science, and English respectively (i.e., RQ1) and (2) the percentage of 12th grade students who apply to, matriculate, and persist through the first year of college.

2. *Evaluation of Program Implementation*

The implementation evaluation will examine the extent to which critical elements of APTIP are implemented as described in the Logic Model. The Logic Model posits increases in student achievement and college-readiness through Program Management (changes in school culture), Teacher Supports (professional development), Student Supports (extra time on task), and Incentives. The implementation evaluation goals are to: (1) provide formative feedback on APTIP implementation, (2) measure implementation fidelity, and (3) describe the service contrast between APTIP and non-APTIP schools. This evaluation will build on the Dell Perot data management system that NMSI uses to track APTIP implementation (see Section IV.1.b) and will also include surveys, interviews, and focus groups to gather data on how APTIP is actually implemented in the schools. The analysis will also include a less extensive collection of

data from comparison schools through interviews and brief surveys, primarily to establish baseline practices in providing AP courses and how these practices may be changing over time.

a. Phase 1: Pre-Implementation (January 2012 – June 2012)

AIR will review the Dell Perot data management system used by NMSI and develop an auditing plan to be implemented and refined throughout the first six months of the project. The audits will include analyzing a random selection of Dell Perot records for fixed time periods to track adherence to the Logic Model. AIR will construct data collection instruments to (1) expand evaluation of APTIP implementation and (2) measure the service contrast between APTIP and non-APTIP schools. AIR will also develop protocols and conduct interviews with the NMSI State Agents and State Content Directors to provide third-party feedback on how key partners view their relationships with NMSI and how the Logic Model is realized in schools.

To measure APTIP implementation, AIR will design and field-test electronic logs for Lead Teachers and Content Directors to capture the Teacher Supports aspect of the Logic Model. This will include measuring the types and duration of school-based professional development activities not currently tracked in the Dell Perot system or the fidelity of implementation during the 2013, 2014, and 2015 AP teacher summer trainings. AIR will also conduct phone interviews at the beginning and end of the school year with the principal, the AP Lead teacher, and a randomly selected teacher (possibly restricted to a specific field) to obtain information on the current and past AP course offerings and supports, in addition to support NMSI will provide or has provided. Initial interviews will establish a baseline, but as implementation proceeds, AIR will identify issues affecting APTIP implementation, including perceptions of the quality of professional development, reporting requirements, and incentives. AIR will also conduct two

focus groups each year with a sample of teachers from APTIP schools to obtain additional information on how APTIP is implemented and factors that may support its success.

The Logic Model's Student Support feature will be evaluated using surveys given to approximately 20 students at each school that include topics such as number and type(s) of AP courses, participation in AP-specific tutoring and support, and attitudes related to AP course-taking. The Incentives aspect of the Logic Model will be encompassed in both the student and teacher surveys, while the Management Support piece is tracked with surveys for principals, AP coordinators, teachers, and Lead Teachers. The Teacher and Lead Teacher surveys will address topics such as teacher background characteristics, AP organization at the school, and AP-specific training and support systems for teachers. For all instruments, AIR will communicate regularly with NMSI's National APTIP Director and conduct a limited number of in-depth interviews with APTIP teachers to inform and improve the survey development process.

AIR will also establish processes and incentives for collecting basic implementation data in the non-APTIP comparison schools. With NMSI's assistance, AIR will seek limited information on AP offerings and supports at the schools using a short electronic survey (with a paper option) followed by two interviews each year with an individual who is familiar with AP offerings and school support, as identified by the principal. To help enroll schools, comparison schools will receive a $250 gift card to be used for library resources, and the participating teacher or AP coordinators will receive two $50 gift cards (one for each interview). To the extent possible, protocols similar to those used at APTIP schools will be used in comparison schools.

b. Phase 2: Measuring APTIP Implementation

In Year 1, the first cohort of schools will implement APTIP per the Logic Model, and implementation data will be entered into the Web-based Dell Perot system. Appendix J, Exhibit

4 provides a description of data collection instruments that will be used to measure implementation. In **Year 1**, an AIR evaluation team member will attend the first teacher training to test the fidelity form and will review the form to ensure it captures the desired data. AIR will also monitor the AP Teacher, Lead Teacher, and NMSI Content Director logs on a monthly basis to: measure implementation; administer the teacher and student surveys (spring) and collect syllabi from non-program AP teachers (spring) to measure the service contrast; conduct site visits to a subset of APTIP schools (spring) to measure implementation; and interview NMSI State Agents and Content Directors (spring) to provide formative feedback to NMSI. This data collection plan will be repeated during **Years 2-3**.

IV. NMSI'S APTIP MANAGEMENT PLAN & PERSONNEL

1. Management Plan to Achieve Goals, On-Time and Within Budget

a. High-Level APTIP Implementation Timeline[44]

ACTION ITEM	START DATE	END DATE
**NOTE: Asterisks indicate a one-time occurrence; remaining start and end dates are for the first year of the program and repeat the next 2 years. All items repeat for each cohort of schools.*		
*NMSI determines school interest	START: 7/1/2011	END: 12/1/2011
*NMSI conducts site visits	START: 7/1/2011	END: 12/1/2011
*Schools and districts sign a Letter of Agreement	START: 2/1/2012	END: 4/1/2012
Teachers access the NMSI Teacher website and receive related training	START: 4/1/2012	END: year-round
Assign local and/or national AP subject experts to each teacher	START: 1/1/2012	END: year-round
AP Teachers attend a week-long summer institute	START: 6/1/2012	END: 8/15/2012
Order equipment/lab supplies	START: 5/1/2012	END: 9/1/2012
Pre-AP Teachers attend a week-long content training	START: 6/1/2012	END: 9/1/2012
AP Teachers and administrators receive individualized bonus numbers	START: 8/1/2012	END: 9/1/2012
NMSI requires detailed data collection	START: 5/1/2012	END: year-round

[44] This timeline outlines the most basic APTIP requirements. Appendix J, Exhibit 2 includes a detailed action plan grounded in APTIP's Logic Model and detailed timelines that track the milestones and requirements of APTIP.

ACTION ITEM	START DATE	END DATE
AP teachers attend 4 vertical team meetings with their Pre-AP teachers	START: 9/1/2012	END: year-round
AP teachers attend 2-day content training	START: 10/1/2012	END: 12/15/2012
All 10th graders take PSAT exams	START: 10/1/2012	END: 12/15/2012
Students attend tutoring at least 1 hour per week	START: 9/1/2012	END: year-round
Students and teachers attend at least 3 Saturday study sessions per subject	START: 11/1/2012	END: 5/15/2013
Students take mock exams	START: 1/1/2013	END: 4/15/2013
Teachers provide AP predictions for their students	START: 3/1/2013	END: 4/1/2013
NMSI analyzes College Board AP exam results	START: 7/1/2013	END: 10/15/2013
Teachers, students, and administrators receive incentive payments	START: 8/1/2013	END: 9/30/2013

b. NMSI's Fiscal and Programmatic Management Plan & Milestones

NMSI's comprehensive, standardized fiscal and program management systems set it apart from other scaling projects by providing a structured mechanism that ensures effective, faithful replication of APTIP. This system is essential for performance accountability and allows NMSI to **tailor its technical and programmatic assistance** to guide successful implementation.

i. Setting & Monitoring Milestones

Performance measurement is a cornerstone of NMSI's APTIP. NMSI believes APTIP partners must have a clear understanding of the mechanics and goals of the program. To establish these goals and to track APTIP progress in reaching them, NMSI identified 53 required milestones to ensure that APTIP is always on pace to achieve increased student achievement and to encourage APTIP expansion and sustainability. These milestones align with the Logic Model: (1) program management, including metrics with specific, quantifiable goals designed to drive improvement and characterize progress made under each APTIP Element of Success; (2) teacher supports; (3) student supports; and (4) incentives. These **53 milestones define the APTIP deliverables** by which NMSI monitors APTIP. By tracking and tying completion of milestones to quarterly distribution of funds, NMSI ensures accountability for results and program fidelity.

NMSI also sets milestones for its own operations to ensure that it effectively manages not only school-level APTIP implementation, but also the entire APTIP scaling effort. These **24 self-monitoring milestones** follow NMSI's project management against measureable outcomes. See Appendix J, Exhibit 2 for detailed charts describing each set of milestones.

ii. NMSI's Electronic Management System, Created by Dell Perot Systems

NMSI's online data management system provides timely, Web-based quality control that also allows NMSI to gather and analyze national-, regional-, and school-based data at any given moment. This user-friendly management vehicle tracks and gathers the essential APTIP data components that are critical to evaluating and measuring results. This allows NMSI to provide APTIP monitoring, feedback, and support and is an essential and effective technological solution to organizing and processing the day-to-day operations of APTIP at all levels.

The data collection and management system has the following operational features: a Web application program; user-ID and password protected access; systems "dashboard" portals allowing access to data and program information; toolbar buttons/icons that allow manipulation and storage of Word, Excel, and PDF files; and data storage and retrieval files, including student enrollments and AP national exam results, disaggregated by demographics.

NMSI's electronic management system facilitates extensive data analysis. 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, disaggregating by subject, by discipline (math, science, English), by gender, by ethnicity, and by low-income status to calculate percentage increases and to evaluate unexpected outcomes. NMSI also compares these

AP exam score results, by subgroup, to state and national averages.

When analyzed across a cluster of schools in an LEA, among schools within the same state, or even as a comparison at the national level, these data allow NMSI to generate an effective and informative feedback loop that facilitates APTIP's constant improvement and that targets lagging schools. The analysis is the basis of the APTIP monitoring, guidance, and support that NMSI provides its partner LEAs. NMSI and NSAs conduct face-to-face meetings with each school to discuss trends in enrollment and results for each subgroup so that the schools can determine their upcoming goals each year. By the end of the third year of implementation, schools can complete this review on their own. This analysis is also an essential and effective technological solution to organizing and processing the day-to-day operations of APTIP at all levels, which, in turn, facilitates frequent, timely feedback on APTIP progress to program participants and partners.

iii. NMSI's Budget Management System

Each NSA prepares an annual budget that includes expenditures for administrative and program funds. In order to ensure that program milestones are complied with as requirements, rather than as aspirational goals, NMSI provides administrative funding on a quarterly basis *only after verifying compliance with the financial and operational milestones*. Additionally, each NSA submits invoices for program expenses on an on-going basis throughout the year. NMSI reviews these invoices to ensure compliance with budget limits and guidelines.

Each NSA must also report operations results and metrics for all expenditures on a **monthly basis on NMSI's Web-based reporting system**. The Chief Financial Officer reviews these expenditure reports to compare the budgeted expenditures with the actual results in order to determine compliance with the agreed-upon, budgeted financial milestones, including all match requirements. If, for any reason, financial milestones are not met in a reasonable time, NMSI

management intervenes to understand the issues and the necessary steps to return to compliance. If it is determined that compliance is not possible, funding will be discontinued.

iv. NMSI's Programmatic Quality Control Management System

NMSI incorporates multiple layers of quality control into APTIP replication. First, NMSI's implementation structure, as detailed in Section II.1.b above, clearly defines the responsibilities that each partner must assume to ensure faithful replication. Second, the resources that NMSI provides for APTIP implementation, as detailed throughout this Section, also allow NMSI to continually monitor APTIP replication. Third, the data management structure described above ensures that APTIP implementation proceeds per NMSI's requirements and timelines and also allows NMSI to provide prompt and tailored assistance where needed.

2. Qualifications & Experience of NMSI Staff in Managing Complex Projects

NMSI's project leaders are amply qualified to guide implementation and have extensive experience managing complex projects. NMSI's team includes: (1) the National APTIP Director who designed APTIP and manages its current replication in 320 schools, (2) the Director of Standards and Quality who oversees curriculum quality and consistency across those schools and states, (3) a Program Director for each subject area (math, science, and English) who guides tailored professional development and teacher support at the state, school, and even individual teacher levels, and (4) a Regional Director who acts as the account executive by traveling to the states on a monthly basis to manage day-to-day implementation at the NSA, LEA, and school levels and to guide communications strategies with state and local governments and media. Those APTIP team members are:

Gregg Fleisher is the National APTIP Director for NMSI, and he created APTIP, including its current structure, budget, and implementation model, based on his years and experience as a

teacher in Texas. He will oversee APTIP implementation at the schools. As an AP Calculus teacher in Dallas in 1993, Mr. Fleisher's students represented 10% of Texas' passing AP Calculus exams for African-American students. In the late 1990s, as a calculus teacher and Lead Calculus teacher for 9 Dallas high schools, Mr. Fleisher's students represented 3.3% of the entire country's passing AP Calculus exams for African-American students. Mr. Fleisher adds important field experience in teaching AP classes and has managed the NMSI APTIP team to produce impressive results in 320 schools nationally.

René McCormick is the Director of Standards and Quality for APTIP. She develops AP science curriculum and oversees AP teacher training in math, science, and English for NMSI. Ms. McCormick has not only taught AP Biology, AP Chemistry, and AP Physics, she was also a member of the AP Chemistry Test Development Committee, the committee which writes the AP Chemistry Exam, from 1999-2001. Her syllabus is currently published in the AP Teacher's Guide, and she authored the chapter on using technology in the AP Chemistry classroom.

Lin McMullin is the Director of Mathematics Programs for APTIP. He works directly with APTIP students and teachers, maintains a website with resources for teachers in the program, leads teacher institutes and workshops, and supports and advises APTIP's mathematics content directors. As a high school mathematics teacher for 34 years, he taught AP Calculus AB and BC and served for 17 years as a reader or table leader for the AP Calculus exams.

Pat Sherbert is the Director of English Programs for APTIP. In this role, she advises and oversees English content directors across all implementation sites, creates annual training sessions for new and experienced AP teachers, presents AP genre literacy and composition training sessions at AP Summer Institutes, and writes content curriculum for the APTIP website. She previously served as Advanced Placement Coordinator for the largest high school in

Oklahoma, and served as an Educational Testing Services consultant for Advanced Placement from 1991-2011, earning the designation of Assistant Chief Reader.

Carol Leibl is a veteran educator who serves as the Director of Science Programs for APTIP where she is responsible for teacher training and curriculum development for the AP biology and AP environmental programs. She leads Saturday student study sessions and trains teachers at the summer Advanced Placement Institutes. Recently, Ms. Leibl has also taken on the position of Program Manager for APTIP schools in Killeen, Texas that service Fort Hood. She has been a College Board consultant since 1985 and has been a reader for the AP Biology Exam.

The Regional Director servicing this grant will be hired, and NMSI's Chief Financial Officer, who has six years experience in that role in the non-profit sector, will execute the financial management plan described in Section IV.1.b.

3. NMSI's Capacity to Scale to the Regional Level by the End of the Grant Period

a. NMSI's Expertise & Scaling Strategy to Ensure Faithful Replication

NMSI has developed a strategic scaling model that is grounded in experience and past success and that provides an effective blueprint for scaling. While many entities recognize the need to replicate innovations that are working, some do not understand or know how to identify and transport the successful elements of one program into a different setting. NMSI understands that scaling requires a deliberate methodology and continuous management, and its replication of APTIP to over 300 schools has proven that its strategy of scaling is successful. NMSI has detailed its scaling strategy in its publication "Taking Effective Programs to Scale" (see Appendix J, Exhibit 5). NMSI's basic scaling tenants are:

Selecting programs already proven to be successful with documented results – APTIP has over 10 years of sustained, significant impact on student achievement. Results from scaling

APTIP in Texas and across six states demonstrate that APTIP achieves significant, sustained success in a wide variety of schools (see Section I.4).

Identifying the program's key components – Successful replication depends on identifying a common core of indispensable elements that produce the significant results shown in the pilot program and faithfully preserving these. While variation in how the Elements are implemented in various environments is permitted, the core Elements must be maintained in order to establish benchmarks for replication. APTIP's Elements of Success are described in Section II.1.a.

The program should not be cost prohibitive – Not only is APTIP cost effective, it also provides effective interventions that have lasting, long-term impacts on school districts (such as teacher training and vertical teaming) that continue to produce results even after the grant period. APTIP also produces cost-savings for students who receive tuition-saving college course credit.

Selecting the right entity to implement the program – NMSI selects scaling partners that have capacity, a framework to produce results, access to state policymakers, and a commitment to performance management and program expansion.

Instituting performance management and rigorous program monitoring – Clear performance goals and milestones are a vital element of successful replication. As such, NMSI ties periodic release of funds to fulfilling these pre-determined milestones so that carrying out these activities becomes the implementer's top priority.

Establishing simple and effective collection of evaluation data – Without objective data collection and analysis, efforts at scaling can be futile. NMSI links data collection to the pre-determined milestones described above to ensure faithful replication of the APTIP model.

Building partnerships and advocacy – Advocacy, as used here, means ensuring that state and local decision-makers hear about APTIP, see it in action, receive periodic updates, and even

serve in partnership roles.

Communicating success – Communication includes more than just media, brochures, editorial opinions, and presentations; it requires events that serve as a physical display of success for recognized and respected officials, policymakers, elected officials, business leaders, parents, and students who all share aspirations for continued program expansion. These events create program awareness, recognize accomplishments of key players, highlight students, enlist commitment from partners, and are the ingredient that builds and sustains momentum. For example, in Alabama, Governor Riley attended the APTIP-sponsored back-to-school event to personally present each school with its APTIP goals for the coming year. His presence showed statewide commitment to APTIP and emphasized its priority at a high, statewide level.

b. NMSI's Capacity: Qualified Personnel

NMSI will dedicate the APTIP team members whose qualifications and experience are described in Section IV.2 above to managing and overseeing APTIP implementation in Colorado and Indiana. Each of these key personnel has capacity to manage the project. The six states currently replicating APTIP are in their fourth year of replication and have therefore transitioned into a much more self-sustaining role. While NMSI staff will still devote resources to those states, the NSAs more independently manage implementation. This, incidentally, is exactly the program's design: to increase self-sustainability until NSAs operate autonomously, from both a programmatic and financial perspective, by the end of the grant period. As a result, NMSI's APTIP team can devote ample time and energy to scaling APTIP to Colorado and Indiana.

c. NMSI's Capacity: Financial Resources

NMSI has significant financial capacity to scale APTIP regionally and nationally. To date, over $160 million has been invested in NMSI by the Bill & Melinda Gates Foundation, the

Michael and Susan Dell Foundation, the Carnegie Corporation of New York, Perot Systems (now Dell Perot Systems), IBM, Texas Instruments, ExxonMobil, Northrop Grumman, BAE Systems, Lockheed Martin, the Boeing Company, and others. NMSI does not seek a waiver of the i3 match requirement. In addition to the 10% match that NMSI will provide, NMSI requires that its implementation partners match NMSI's commitment to ensure sustainability. The NSAs in Colorado and Indiana have already raised almost half a million dollars toward that goal. Thus, the total financial resources applied to scaling APTIP far exceed the i3 grant requirements.

d. The Project's Management Capacity

If funded with an i3 grant, this partnership will bring the success of APTIP to 180 high schools and feeder middle schools in Colorado and Indiana. NMSI has the resources and capacity, as well as the drive and commitment, to continue increasing access to rigorous and engaging coursework in STEM in order to improve student achievement and college-readiness, especially for high-need students and those traditionally underrepresented in STEM, such as minorities and women. NMSI has adopted a two-tier management system to ensure proper oversight at the state level and fidelity to the program model at the national level.

At the state level, NMSI partners with NSAs that have proven leadership, access to state policymakers, and connections with strong partners who have fundraising and convening power. In addition, **NMSI enhances the capacity of each NSA** by providing the training, monitoring, leadership, and assistance necessary to rapidly scale APTIP throughout the state. NMSI's national resources combined with each NSA's statewide capacity ensure successful APTIP replication. Both NSAs' statewide capacities are summarized below, and resumes of key personnel are included at Appendix F.

The NSA for Indiana is the University of Notre Dame. The NSA Director, Karen Morris, has

helped advance the state's AP initiatives, giving her the understanding of both the AP curriculum and of what students must master in order to become college ready. Further, the Indiana Department of Education is a valuable resource and a principal partner in seeking to bring APTIP to the state. Indiana also has notable private sector support, with a $170,000 grant from The Lumina Foundation for Education and a $55,000 grant from the Lilly Foundation.

The Colorado Legacy Foundation (CLF) is Colorado's NSA. CLF supports the Colorado Department of Education's (CDE) work improving public schools. CLF seeks out, tests and recommends innovative ideas to assist in changing education policy for the state of Colorado toward the end of increasing student achievement. CLF's President harkens from the CDE as well. The direct connection to the CDE makes CLF uniquely suited to act quickly and be in a strong position to scale APTIP. This partnership also encourages leveraging public dollars with private funds, using temporary investments of private resources to build capacity and plan for long-term sustainability and systemic reforms at the state level. CLF has raised $251,000 from the Daniels Fund, the JFM Foundation, the AMGEN Foundation, and others.

At the national level, NMSI manages these NSAs with face-to-face supervision, assistance, and intervention that is tailored to each state. This constant support and monitoring is first provided at the *implementation* level in each state by a Regional Director, the National Content Directors, and the Lead Teachers. Second, NMSI's National APTIP Director, the Director of Quality and Standards, and the Program Directors all monitor the NSA's *management* to ensure consistency and fidelity to the program model nationally. Finally, NMSI's management support also incorporates tangible resources to guide the logistics of APTIP replication, including a comprehensive Operations Manual (Appendix J, Exhibit 6) that details each aspect of APTIP implementation.

V. CONCLUSION

This partnership addresses persistent challenges in STEM education (improving student achievement and increasing college-readiness) for high-need students by scaling the Advanced Placement Training and Incentive Program. APTIP provides equity, access, and equal opportunity to traditionally underrepresented students while providing students, teachers, and administrators with the tools to successfully increase student achievement and college-readiness in STEM. Research strongly suggests that scaling APTIP to 40 LEAs with 180 high schools and feeder middle schools to reach 90,900 students will have a substantial and important effect on improving student achievement and increasing college enrollment and completion rates, especially for high-need students and those traditionally underrepresented in STEM subjects.

NMSI has already made significant progress in an increasing number of schools across six states. NMSI is prepared to build on this success and scale APTIP even more broadly. NMSI has a strong methodical scaling strategy, programmatic and financial capacity and resources, management plan, and support of dedicated partners from public, corporate, and philanthropic sectors to noticeably address the nation's needs to increase student achievement, college enrollment, and college completion rates. With i3 funding, APTIP can continue to be a model for best practices in creating a culture of college-readiness in schools to support students, especially high-need and traditionally underrepresented students, as they reach to achieve beyond their expectations.