STEM Learning Opportunities Providing Equity (SLOPE)

Innovations that Complement the Implementation of High Standards

PROJECT NARRATIVE

In response to CFDA 84.396C.

APPLICANT
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Alliance for Regional Collaboration to Heighten Educational Success (ARCHES)
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EXTENT OF AGREEMENT
Alliance for Regional Collaboration to Heighten Educational Success (ARCHES) stipulates that it will comply with all of the terms, conditions, and provisions included in the Government’s solicitation. ARCHES further agrees that it will provide the services offered in its proposal in accordance with the pricing structure submitted in its proposal.

May 11, 2010

This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed—in whole or in part—for any purpose other than to evaluate this proposal or quotation. If, however, a grant is awarded to this offeror as a result of—or in connection with—the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government’s right to use information contained in this data if it is obtained from another source without restriction. The entire proposal is subject to this restriction.
CPP (# 6) Innovations that Support College Access and Success.

The college readiness portion of our intervention builds on the research on creating a college-going culture (McClafferty et. al. 2002; McDonough 2005). Key elements described in the research include providing students with clear information, counseling, assessment testing, pre-college experiences, and ensuring family involvement in learning about the college going process and expectations. Our college readiness component will help students develop knowledge of the different college systems, college preparation courses required in high school, the relationship between mastery of mathematics in high school and future acceptance to college and STEM careers, college and career pathway opportunities, opportunities for financing college, and the college application process. We will also provide support to students and families through workshops and college visits.

CPP (# 7) Innovations to Address the Unique Learning Needs of Limited English Proficient Students.

Teachers will learn how to teach the language (Wong et. al. 2000) that students need to gain access to the content of algebra. Professional development will include strategies for working with English Learners (EL) drawn from the current theory (Dutro & Moran 2003) that language should be explicitly taught and should focus on the functions and forms students need to gain access to the content. Teachers will learn to teach the academic language students need in mathematics (Advani et. al. 2008; Dutro & Moran 2003) through strategies such as teaching sentence frames, focusing on the unique structures and vocabulary needed to be successful in algebra, engaging in structured practice of the language needed for math, and using project-based learning, an approach that strengthens language learning.

CPP (# 8) Innovations that Serve Schools in Rural LEA’s.

ARCHES works extensively with rural California schools, including Merced, Stanislaus, Lake, and Mendocino counties. We have successfully employed distance-learning communications technologies including webinar conferencing, video conferencing, and regularly scheduled teleconferencing. In this intervention a math coach will meet regularly with teachers
via web-based technology, allowing teachers from rural schools to participate fully in high quality reflective teacher collaborative coaching. Further, the curriculum in our project-based curriculum features topics that are relevant to the daily lives of students in rural areas.

The high number of farm workers in California’s agriculture industry creates an urgent need for an innovation that can address limited English speakers in rural settings. The focus on EL students described above will greatly benefit rural schools in California. Eight of the 14 schools in our study are designated rural schools on the Federal Rural School Achievement program.

**A. A CLEAR NEED FOR HIGHER MATHEMATICS ACHIEVEMENT**

A major factor in our nation’s international economic competitiveness is the strength of our future workforce in science, technology, engineering, and mathematics (STEM). How well we prepare K-12 students for these jobs—through curricula that communicate the excitement of STEM learning, implementation of high academic standards, effective teaching strategies that reach diverse learners, and programs that help students understand how to succeed in high school and transition to college—will determine success or failure in meeting this workforce need.

Today, California is failing at this critical task. High schools are producing too few graduates with the mathematics skills and motivation to pursue STEM postsecondary education and careers. Three contributing factors stand out: poor mathematics performance—especially in California’s standard of 8th grade Algebra I—which leads students to eschew or fail in higher-level mathematics courses; curricula that fail to engage students in mathematics; and inadequate knowledge of and preparation for the high school courses required for college entry and postsecondary education success. This project tackles this problem by improving performance in 8th Grade algebra and building a college-going culture in schools that serve low-income and underrepresented minority California high school students.

The data on students’ lack of college academic readiness—especially in math—are sobering. In 2008, only 23% of California high school seniors completed the courses required for state university entrance (CPEC 2010). As many as 70% of entering community college students
nationally must enroll in remedial mathematics courses, derailing college success for many students (Blum 2007).

This lack of college-readiness is even more severe among minority students, who in 2007 made up 40% of California’s K-12 population. Only 9% of African-American males and 10% of Latino males completed the courses required to enter one of California’s state universities (CPEC 2010). Results from the California Standards Test (CST) for Grade 8 algebra show a 22 to 30 percentage point gap between white students and their Latino and African American peers (CPEC 2010). As a result, inadequate numbers of minority students can move beyond the basics of elementary algebra to complete the higher level mathematics courses needed for college success (U.S. Department of Education 2007).

This project addresses Absolute Priority (#3): Innovations that Complement the Implementation of High Standards and High Quality Assessments and 3 Competitive Priorities: College Readiness (#6), Strategies to Support English Learners (#7) and Strategies to Support Rural Schools (#8). Our intervention will increase the success of under-represented high needs students in algebra and STEM high school pathways through rigorous and relevant project-based contextual study that accelerates learning of fundamental math concepts. In our project schools, an average of 76% of students qualify for free or reduced-price lunch; 81% of students are under-represented minorities (excluding two small rural schools); and 92% of the schools have less than half of 8th grade students meeting the Grade 8 algebra standard. (See Student Demographics Appendix H.) This project focuses on the highest needs students in those schools. These schools were chosen because their demographics represented a range of high needs, low SES students, representing the broad demographic make up of California. The project will translate the California Mathematics standards related to mastering 8th grade algebra—a gate-keeping course that determines students’ ability to complete a college-preparatory course sequence—into classroom practices that meet the needs and build the interest of all students, including high-need students, in STEM learning. (The Center for the Future of Teaching and Learning 2005) And, it will incorporate strategies that address issues of college
affordability and financial aid, while building a school and family culture with future expectations to attend and succeed in college. (Ferguson 1988)

**An Exceptional Approach**

There are many approaches that attempt to improve student academic performance in Algebra I. Our model stands out in its ability to combine a set of individually successful strategies to create a powerful new multi-faceted innovation.

1. Our project-based pre-algebra and algebra curricula address both the motivational and skills-based deficiencies that lead many adolescents to question their abilities in mathematics and reject this important field of study (Middleton & Spanias, 1999).

2. Our three-part intensive student intervention (an accelerated Summer Algebra and College Exploration Academy, STEM-themed, project-based Algebra 1 curriculum; and project-based extended-day algebra support program) delivers an engaging, hands-on, project-based curriculum that teaches students fundamental pre-algebra and algebra concepts through relevant, rigorous, collaborative projects. Rather than wait for students to fail and provide remediation, the accelerated Summer Academy gives students a deep understanding of key pre-algebra and algebra content before enrolling in Grade 8 Algebra. Combining these interventions is an innovative way to reach many high needs students who enter Grade 8 with mathematics deficiencies that cannot be remedied solely through additional time devoted to traditional instruction during the school day.

3. Our intervention recognizes that support and professional development is critical to develop teachers who effectively implement innovative strategies designed to address the needs of all students, including English learners. We further recognize that inexpensive technologies can be employed to break through the isolation barriers teachers face in rural areas. As such, the intervention incorporates professional development and coaching to build a community of learners through regional collaboration, as well as web-based means. Incorporated into the professional learning will be instruction on the use of the Mathematics Diagnostic Testing Program (MDTP) for assessment and diagnostic purposes. (See Appendix H: MDTP)
A Clear Set of Goals and an Explicit Strategy

**Goal 1: Participants will master California Algebra I standards in Grade 8.**

- **Objective 1A:** 80% of students will test proficient in algebra on the 8th grade CST.
  
  **Measure:** California Standards Test.

- **Objective 1B:** 60% of students will test algebra ready at the end of the summer intervention.
  
  **Measure:** California Mathematics Diagnostic Testing Project—Algebra Readiness Test

- **Objective 1C:** Students not testing “algebra ready” at the end of the summer intervention will participate in an after-school intervention, and 50% will test “algebra ready”.
  
  **Measure:** MDTP—Algebra Readiness Test.

- **Outcome:** Significantly more under-represented students will pass Algebra I and be prepared and enroll in higher level mathematics courses in high school.
  
  **Measure:** Transcript documentation.

**Goal 2: Participants will increase college knowledge, and will pursue a college preparatory sequence of courses in the future.**

- **Objective 2A:** 60% of students will enroll in a college prep course in freshman and sophomore years. **Measure:** Transcript documentation.

- **Objective 2B:** 90% of students and parents will increase college knowledge.
  
  **Measure:** College readiness survey.

- **Outcome:** Increased number of under-represented students will be on a college track at end of the grant period. **Measure:** Transcript documentation.

**Goal 3: Participants will enter STEM program of study pathways in high school.**

- **Objective 3A:** 60% of participants will choose a STEM-focused pathway in 9th grade.
  
  **Measure:** Transcript documentation.

- **Objective 3B:** All students will engage in STEM related-learning through STEM-focused projects that deliver mathematics content.
  
  **Measure:** Documented lesson plans and student attendance.

- **Outcome:** The number of high needs students who enter STEM pathways will increase
significantly. **Measure:** Grade 9 pathway enrollment documentation.

To achieve these goals, objectives and outcomes, the intervention involves three major activities: (1) Summer Algebra and College Exploration Academy (for “rising” 8th graders); (2) STEM themed, project-based Algebra I curriculum in Grade 8; and (3) Project-based, extended day Algebra Support Program, also in Grade 8. (Appendix H: Design schematic)

Teachers will receive professional development in mathematics project-based learning curricula, addressing language needs of English Learners, and in college readiness prior to the Summer Academy and ongoing throughout the school year. Reflective Teacher Coaching conducted twice a week for 30 weeks via the web and support in using the Mathematics Diagnostic Testing Placement exam will further enhance the teachers’ skills, build a learning community, and allow for focused attention on critical needs.

**Design Elements: Activities to Meet Objectives**

**Activity I: Summer Algebra and College Exploration Academy**

Each of the 6 participating school districts will conduct a Summer Academy for 3 classes of 30 high needs students for a total of 90 students per district. Using our field-tested curriculum, Academy students will engage in 75 hours of instruction in project-based pre-algebra – 4 days/week. (See Appendix H. for unit descriptions.) This instruction uniquely incorporates the learning of foundational mathematics while engaging students in intriguing problems, all the while introducing the college-readiness concepts of working in a team and documenting their work. The first unit asks students to design a wind turbine that transfers the most wind energy into electricity. While learning about the design elements of a rotor, students review how to perform arithmetic with fractions, how to measure angles, and how to properly graph data sets. Subsequent units use project-based learning to teach proportional reasoning, scale, ratios, integer operations, rules of exponents, permutations, and more. During the Summer Academy – 24 hours (1 day/week) will be devoted to college pathway preparation and college exposure. An integral aspect of the Academy is family involvement in workshops focused on supporting students on college and career pathways.
Activity II: STEM themed, Project-based Algebra I Curriculum

All Summer Academy students will be placed in 8th grade Algebra I courses that are supplemented by 3 units of our project-based, STEM-themed curriculum. (See Appendix H. for unit descriptions.) These units build upon the knowledge and skills students developed in the Summer Academy. The units incorporate the concepts of solving single-variable linear equations, graphing and interpreting two-variable linear functions, and solving and graphing linear inequalities through projects that include technical drawings of schematics of 3-d puzzle pieces, air traffic control plans that safely land several planes in the shortest amount of time, and building a small scissor lift and communicating its range of motion and size as inequalities.

Activity III: Project-Based Extended Day Algebra Support Program

Summer Academy students who do not achieve at the proficient level in the post-test administration of the MDTP Algebra Readiness exam at the end of the Summer Academy will be recruited into the Extended Day program. This program will operate after school for 30 weeks, 3 days a week for 1.5 hours each day. The curriculum will combine pre-algebra and algebra instruction, support for projects included in the regular Algebra I class, and additional projects not included in the Algebra I class. Acknowledging the challenge of enticing students to attend an after school math program, attendance will be reinforced through incentives and rewards.

B. STRENGTH OF RESEARCH, SIGNIFICANCE AND MAGNITUDE OF EFFECT

Research-based Findings and Hypotheses

Our hypothesis draws from research-based findings as well as promising results from implementation of the 3 components of the proposed intervention. One of the main intended effects of the project—successful Algebra I completion—will have significant consequences that reach far beyond the test sites.

Hypotheses: (A) Providing high needs students a 3-tiered intensive approach: (1) accelerated algebra preparation through project-based, relevant pre-algebra and algebra and college knowledge in the summer; (2) an enriched curriculum in the academic year and (3) after-school
support; will result in significant increases in algebra passage rates and subsequent choices for
STEM and college pathways. (B) Providing a well-designed, project-based curriculum with
coaching to support implementation and strategies for English Learners and college knowledge
will provide teachers with the skills to accelerate learning for high-needs students.

We draw on the research literature on summer learning (Cooper et. al. 2000); project-based
learning (Wong et. al 2009) teacher professional development and coaching (Joyce and Showers
2002), family involvement, college preparation (McClafferty et.al. 2002; McDonough 2005) and
effective strategies for English Learners (Advani et. al. 2008; Dutro & Moran 2003). In addition,
we present data from our combined experience piloting the model and each of the components.

The research suggests that summer programs can mitigate the loss of mathematics knowledge
(Cooper et. al. 2000) that normally occurs over the summer particularly among low SES students
(Jamal 1994) provided the curricula vary from the normal academic year (Karweit 1985).
Further, project-based learning (PBL) promotes greater retention of knowledge (Wong et. al.
2009). This approach has shown to be more effective than traditional instruction in mathematics
and science for both skill development and conceptual understanding (Boaler 1997; Cognition
and Technology Group at Vanderbilt 1992; Capon & Kuhn, 2004). Lower-achieving students
perform better, and all students improve in 21st century skills like problem solving
(Mergendoller et. al. 2007; Gallagher et. al. 1992). The college readiness portion of the model
builds on the research on creating a college going culture (McClafferty et. al. 2002; McDonough
2005). The necessary elements described — college talk with clear information and resources,
counseling, testing and pre-college experiences, and family involvement as part of the college
culture — all are included in our model. A study by Wimberly and Noeth (2005) reports that
students receive help from parents (67%), teachers (42%), friends (35%), and counselors (25%),
making a case for the component to teach college knowledge to families of students as well as
teachers.

The research based strategies for English Learners (Advani et. al. 2009; Dutro & Moran,
2003) will provide teacher knowledge and planning tools to increase the academic language
students need in mathematics through strategies such as teaching sentence frames and focusing on the unique structures and vocabulary needed to be successful in algebra.

We also draw on the research literature on the role of coaching in changing teacher behavior. Joyce and Showers (1980) note that teachers implement new learning at a much higher rate if they received follow-up coaching and support. Through more recent research Joyce and Showers (2002) noted that instructional coaching in collaborative teams of teachers can provide the support and professional development necessary to advance teaching skills. Edwards (1995) studied 153 teachers involved in a coaching model and found they had a deeper understanding of classroom practices. The coaching model we propose is an expert coach working via the web with teams of three or more mathematics teacher peers collaborating at a site.

**Promising Results that Warrant Study**

This research basis for the proposed intervention is also supported by positive data collected from local interventions with which the submitting organization and partners have engaged:

- The University of California (UC) has provided summer algebra academies in six regions of the state over the past six years. UC developed a college preparation model that combines mathematical skill development with college preparation and family involvement. An analysis of data for 1361 students chosen from students at or below basic on their California Standards Test (CST) scores shows that students in the treatment group made 7 percent growth overall across the state on a pre/post test on the MDTP algebra readiness test and significantly increased passage rates in first semester Algebra I. In addition, on a pre/post college knowledge survey, over the course of the program, summer academy students acquired essential college readiness information and expanded their desire to pursue a four-year college degree.
### College Knowledge

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<thead>
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<th></th>
<th>Beginning</th>
<th>End</th>
<th>Difference</th>
<th>P&lt;.05</th>
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<tbody>
<tr>
<td><strong>Mean Score (0-5)</strong></td>
<td>2.43</td>
<td>3.02</td>
<td>+.59*</td>
<td></td>
</tr>
<tr>
<td><strong>Percent Correct</strong></td>
<td>48.6%</td>
<td>60.4%</td>
<td>+11.8%*</td>
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- A summer effort of the ConnectED project-based learning pre-algebra curriculum leading to STEM career pathways in a rural school in the Central Valley of California showed an average 10 point gain on the 50-question MDTP assessment from a mean of 27.17 to a mean of 37.4 for the 24 students who took the pre and post test. (2009)

- An ARCHES collaborative initiated Student Improvement Through Teacher Empowerment (SITTE) to improve student performance in algebra by supporting teachers in developing innovative teaching approaches for algebra. Using a “responsive teaching cycle” (RTC), teachers successfully focused on “getting through to their students” rather than simply getting through a book. SITTE students (9 – 12 graders repeating Algebra 1) passed at a rate at least 50 percent higher than did similar groups of non-participating students. Subsequent participating cohorts show the same trend suggesting that the effects of SITTE are consistent over time despite inevitable changes in personnel.

Building on the success of SITTE, the collaborative implemented a second intervention. In this program, low performing seventh graders (below “proficient” on the CST) were provided a full-day summer program before entering algebra in the eighth grade. This summer program included a teacher-designed algebra readiness class, a study skills class, and a robotics class. As a result of this intervention, 86% of participating students earned a C grade or better in first semester Algebra 1. Compared with classmates who did not participate in the intervention, target students scored 11.5% better in standardized district benchmark assessments. The following year 90% of the students in the summer intervention passed Algebra 1 as eighth graders in the fall
semester (n= 150 each year). Some teachers reported that starting with a predesigned engaging curriculum for teachers to adapt through collaborative coaching would make this a more scalable approach. Thus, this approach starts with a project-based curriculum and provides the reflective collaborative coaching via web-based technology.

**Positive impact/Magnitude of the Effect**

The cited research combined with these regional and statewide efforts provide us with reasonable evidence of the potential to improve mathematics achievement among high needs students. By combining three promising strategies into an innovative, scalable project, we have strong support for the hypothesis that the project will have a positive impact on improving student mathematics performance, closing the achievement gap, and increasing college enrollment and students entering STEM pathways.

**C. EXPERIENCE OF THE ELIGIBLE APPLICANT**

The California Education Round Table Intersegmental Coordinating Committee (ICC), through its Alliance for Regional Collaboration to Heighten Educational Success (ARCHES), is well positioned to build upon its success at increasing student achievement in California public schools. The Round Table consists of the Chief Executive Officers in California education including:

- Chancellor of the California Community Colleges
- Chancellor of the California State University
- Executive Committee Chair, Association of Independent CA Colleges and Universities
- Executive Director of the California Postsecondary Education Commission
- President of the University of California
- State Superintendent of Public Instruction

As administered by the Round Table and ICC, ARCHES is charged with developing educational collaboratives across the state to increase student achievement among under-represented students. Collaboratives must include leaders of the educational institutions in each region, local business and community leaders, and organizations that serve families. ARCHES
oversees funding opportunities for collaboratives to coalesce the educational institutions and committed partners within a region to close achievement gaps. Beginning with five existing regional collaboratives, the ARCHES alliance has grown to 27 regional sites across California. ARCHES requires collaboratives to provide annual data demonstrating improved academic achievement for all students and closing achievement gaps among demographic groups.

**Past Performance and Improved Student Achievement**

The following examples, in addition to those in the Research Section, demonstrate ARCHES’ past performance in implementing projects of the size and scope proposed as well as its record of work with schools in significantly improving student achievement:

1) The Merced P-16 Education Council where Latino students are more than 50% of the 56,164 students in the region made gains on several indicators: over 15% more tenth graders passed the California High School Exit Exam (CAHSEE) between 2006 and 2008, and 10% more students have met the course requirements for UC/CSU entrance.

2) Ventura County Regional Council, a partnership with 27 business, education and community partners, narrowed the achievement gap on CST scores at one high school from a 17-point difference to a 9-point difference and a 14-point difference to a 6-point difference between Latino student scores and school wide CST scores.

3) Southern Alameda County Regional Education Alliance’s focus to improve the academic proficiency and college readiness of African-American students in Southern Alameda County, a racially diverse area, resulted in raising participation rates in algebra in 8th grade from 17% to 31% among the target population, and passage rates increased from 4% to 22% at a target school district.

4) With support from the Walter S. Johnson Foundation, ARCHES worked in the San Joaquin Valley, a largely rural agricultural area, to increase the number of collaboratives and support them in making progress toward improving student academic outcomes. The numbers of students taking the CA CST test in algebra in 8th grade (rather than in later grades) is an indicator of student enrollment in algebra. Between 2004-05 and 2008-09, the numbers of test -
takers increased by 70.9%. And the proportion of 8th graders scoring proficient or advanced increased by 130.8%.

ARCHES has administered complex statewide projects such as the following:

1) The California Space Education and Workforce Institute contracted with ARCHES to create the California Science Technology Engineering Mathematics Collaborative Action Plan (STEM CAP), a set of recommendations to improve STEM education in California. ARCHES administered the effort creating focus groups and forums across the state to assess the needs and develop a set of recommendations for improving California STEM education. ARCHES recruited, selected, and provided technical assistance to six regional collaboratives that piloted specific recommendations. This resulted in the acclaimed report: *High Stakes: STEM Education. The Essential Ingredients for California Competitiveness* for which ARCHES was awarded the prestigious Buzz Aldrin Space Educational and Workforce Award.

2) Funded by The James Irvine Foundation, ARCHES is in the second of a three-year contract to work deeply with school districts to develop Linked Learning (career-oriented) pathways, primarily with a STEM focus, that combine rigorous academics with relevant content. Through this work ARCHES has built a collaborative relationship with ConnectED, one of the official partners on this grant.

In addition, our partners ConnectED and WestED also have experience working with schools and districts that have closed the achievement gap:

ConnectED is an organization of 20 full time staff and contracted coaches founded four years ago by The James Irvine Foundation. As evidence of success in addressing the achievement gap ConnectED points to data on the Academic Performance Indicator (API) of six schools with which they have been working. These schools increased their API scores by an average of 37 points, including substantial improvements for African-American students (23.3 point increase) and Hispanic students (36.6 point increase). (See Appendix H for more detailed data.)

WestEd, our evaluation partner, brings an extensive portfolio of rigorous evaluations of promising innovations, including studies using quasi-experimental and experimental designs that
compliment the skills provided by ARChES. With over 40 years of experience working directly with LEAs and schools across the country, WestEd has a strong track record of increasing student learning and achievement and closing the achievement gap. For example, their Reading Apprenticeship professional development program, which focuses on increasing literacy learning for adolescents through teacher professional development, has been the subject of a number of experimental and quasi-studies (funded by the National Science Foundation and the U.S. Department of Education’s Institute for Education Sciences) that have shown positive impacts on student achievement. Similarly their Understanding Science model, a professional development program that helps teachers learn major concepts of K-8 science and improve their teaching practice, has documented its effects on science achievement of high-need K-8 students through a series of increasingly rigorous quasi-experimental and experimental studies. A recent NSF-funded large-scale randomized control trial study found substantial effect sizes on gains in teacher knowledge and student achievement. WestEd’s improvement and turnaround services have targeted low-performing LEAs and schools. They have demonstrated the ability to improve student achievement in partnership with several underperforming localities, including Creighton Elementary School District in Arizona, and several districts in California, including: Modesto City Elementary School District, South Bay Union Elementary District, and Lennox School District. (See Appendix H for more details about WestEd’s experiences in improving student achievement in partnership with schools.)

D. EVALUATION PLAN

As the outside evaluator, WestEd has designed a rigorous, comprehensive evaluation to address the basic evaluation questions, “Was the project implemented with fidelity as designed, and did it accomplish the desired outcomes?” The proposed mixed-methods evaluation will use an experimental design, with random assignment to treatment, to examine the impact of the intervention on students. Both quantitative and qualitative data will address formative and summative evaluation questions about study processes, fidelity of implementation of the intervention, and effects of the intervention. Year 1 of the evaluation will focus on collecting and
examining evidence related to program implementation and piloting and refining instruments. Data collected are intended to be used formatively by the study team to improve the intervention and test measures of effectiveness. Summative evaluation data collection will begin in Year 2. A final report will be delivered to the study team at the end of Year 5.

**Evaluation Questions and Data Collection Strategies**

A set of formative and summative research questions guide the evaluation. The primary research questions will focus on the outcomes listed in the project design section of the proposal, impacts of treatment on performance outcomes for students. Secondary research questions will examine more deeply the effect of the intervention by focusing on differential effects of treatment for student subgroups (e.g., racial/ethnic minorities, English language learners [ELLs], female students, and struggling students). Below is a subset of the summative and formative research questions (See Appendix H for the full set of research questions.).

<table>
<thead>
<tr>
<th>SUMMATIVE QUESTIONS</th>
<th>DATA COLLECTION STRATEGIES</th>
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<tr>
<td>1. Are students who participate in the summer algebra program more likely to be prepared for algebra I in grade 8 than their control group counterparts?</td>
<td>Treatment and control students take the MDTP at the end of the summer program/summer school or the beginning of grade 8 (1st day/week of school)</td>
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</table>
| 2. Are students who participate in the summer program and enroll in algebra classes with teachers who have received the professional development intervention more likely to pass Algebra I in grade 8 than their counterparts? | a. Algebra course grades collected for treatment and control students at the end of grade 8 and disaggregated by subgroup  
 b. To inform program improvement, mid-course algebra grades collected for treatment and control students |
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<tr>
<th>FORMATIVE QUESTIONS</th>
<th>DATA COLLECTION STRATEGIES</th>
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<tr>
<td>1. Does participation in the intervention increase student homework completion rates relative to the control group?</td>
<td>Homework completion data collected for students in treatment and control groups throughout their high school math courses</td>
</tr>
<tr>
<td>2. How does participation in the intervention affect students’ attitudes toward mathematics and STEM fields?</td>
<td>Students’ math anxiety and/or attitudes toward math assessed at end of grade 8 for both treatment and control groups via a student survey</td>
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<tr>
<td>3. What is the degree of fidelity of implementation of the intervention by schools, teachers, students and parents? To what degree are teachers able to successfully implement strategies (e.g. project-based instruction) learned through the program’s professional development in their algebra classrooms?</td>
<td>a. Administration of the Stages of Concern Questionnaire (SEDL, 2006) as measure of readiness for intervention</td>
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<td>b. Observations of professional development, the summer program, and enhanced algebra instruction conducted</td>
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<td></td>
<td>c. PD materials and algebra curricular units reviewed</td>
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<td></td>
<td>d. Focus groups with treatment teachers conducted throughout their training (summer and throughout academic year) to assess their ability to implement learned strategies with their students</td>
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Method and Sampling Plan

Study Sites: Description and Selection Process

All 6 of the districts (LEAs) that have agreed to partner in this study have well-established relationships with ICC/ARCHES or ConnectEd; embrace the pathway approach to improving student academic achievement in high school; and have created STEM opportunities within their pathway structures. These districts were chosen for the study because (1) They have previously expressed an interest in or have provided a summer algebra and/or college exploration academy; (2) As a group, they represent the diversity of California geographic regions (i.e. north/south/central; urban/rural); (3) All of the middle schools selected enroll a majority of underrepresented minority/low-income students, as shown in Table 1 in the Appendix.

Study Participants: Students

The eligible pool will be all grade 7 students in the participating middle schools who (1) performed below basic on their California Standards Test (CST) at the end of grade 6, and/or (2) were not achieving a grade of “C” or better in mathematics by spring of 7th grade. After student recruiting at participating middle schools in each of the 6 school districts, 90 randomly selected students from the eligible pool will participate in the Summer Academy, and 90 students will be identified as a control group.

Study Participants: Teachers

All Grade 8 math teachers at each participating middle school constitute the eligible teacher pool for the study. They will be recruited to be Summer Academy teachers with 3 randomly selected from among the volunteers.

From the eligible student pool, students will be recruited to participate in three-part study: attending the algebra academy; agreeing to take algebra in grade 8; and agreeing to participate in the after school program, if warranted. Assuming target recruitment per school is N= 180, half of these students will be randomly assigned to the intervention group (n= 90 or three sections of 30 students per school) and half to the control group. Overall, 540 students will be in each cohort (treatment and control) during each of the three years. The design may be considered a multi-site
(blocked) design with individuals assigned at random to treatment. Data will be analyzed with a two-level hierarchical model, where students are nested within school/district. The minimum detectable effect size for student outcomes in this design is .16 under the following assumptions: alpha=.05; 6 sites are a fixed effect, n per group is 90; sites explain 15% of the variance in outcomes; student-level covariates, such as pretest achievement explain 50% of outcomes, and power is set at .80.

Schools that participate in the evaluation will agree to enroll students in the treatment group into 8th grade algebra taught by a treatment teacher. In addition to receiving algebra instruction from teachers trained in project-based learning, the students will have opportunities for extended tutoring if assessment on an algebra readiness assessment identifies the need.

Students in the control group will have no changes to their class schedules, teacher assignments, or instructional program for the evaluation. They will have no exposure to the intervention. Some may pursue other academic summer school opportunities and some may not; no efforts will be made to influence decision-making. This study will compare the target intervention to “business as usual” for the control group.

Parents/guardians of students in the intervention group will be asked to participate in workshops during the summer to increase their understanding of the college application and admissions processes. They will attend visits to college campuses with their children, as scheduled, and participate in interactive seminars about college readiness. Attendance and responses to a pre and post survey will evaluate their growth.

In addition, four to six algebra 1 teachers from each participating school will be recruited to participate (N=24 to 36). Half (12 to 18) will be randomly selected as the intervention group and the other half will be assigned to the control group. The control group will have no changes to their teaching assignment or instructional programs.1

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1 Doing so is intended to help address the concern that teachers who volunteer to participate may differ systematically from those who do not.
Study Significance

The proposed study has the potential to demonstrate the effectiveness of a multi-level approach (i.e., services for students, teachers, and parents) to supporting the academic achievement that is critically important for success in STEM career pathways and readiness for postsecondary education. The study team seeks to show that (1) High needs students in general and English Learners in particular are most successful in pursuing a STEM pathway when they receive intensive, multi-level support in a core academic 8th grade algebra course. and; 2) Teachers will increase their ability to close the achievement gap with high-needs students when they receive intensive professional development on an enriched project-based curriculum with ongoing coaching support, strategies to work with English learners, and professional development on college readiness for middle school students. This multi-level approach may increase the numbers of students—especially high needs female and minority students—who successfully complete Algebra 1 and subsequently enroll in more advanced mathematics courses, pursue STEM career pathways, and explore postsecondary education opportunities.

E. STRATEGY AND CAPACITY TO DEVELOP AND BRING TO SCALE

This three-tier intervention combined with the capacity of ARCHES and its partners creates a powerful base from which to further develop this intervention and to bring it to scale.

Number of Students Reached

The number of students affected by this intervention significantly increases over the 5 years of the grant: 1,620 students (90 per district, times 6 districts over 3 years) will benefit directly and immediately as participants in the intensive intervention. 13,500 students (18 teachers x 150 students per year x 5 years.) will benefit during the 5 years of the grant, being taught by well-trained teachers. In the last 2 years of the grant, an additional 60 teachers will be trained, creating an institutional capacity for leadership within the districts. This will increase the number of students served by those teachers over ten years to approximately 102,500 (60 x 150 students x 10 years plus 13,500). As can be seen in the Management Plan and District MOU’s
(See Appendix D.) we have the commitment from the districts and the capacity to reach the proposed number of students during the course of the grant period.

**Capacity to Further Develop and Bring to Scale**

The California Education Round Table Intersegmental Coordinating Committee (ICC), through ARCHES, is well positioned to build upon its success at increasing student achievement in California public schools by further developing and bringing this intervention to scale. The Round Table has identified the need for more students passing algebra in 8th grade and entering STEM pathways as a top priority.

With initial empirical evidence to support this intervention, The Round Table represents the 4 California education systems that have the wherewithal to create policy and leverage funds ultimately to make this intervention standard practice throughout middle schools in California. Further, ARCHES and ConnectEd have the capacity to create the statewide community of learners among the ARCHES collaboratives, K-12 and college systems, and ConnectEd’s statewide network of school districts that can introduce this intervention across the state.

**Private-sector Participation and Support**

Both ARCHES and ConnectEd bring significant private sector support to this work, further increasing the potential for expansion and long-term sustainability. We have initiated conversation with several of these organizations and are certain that we can bring the required 20% match to this project.

Specifically, both organizations have current and future funding commitments from The James Irvine Foundation that include support for building STEM-focused pathways, including project-based mathematics and college-readiness curricula, to California high schools. In addition, ARCHES has had significant funding from the Kellogg Foundation and the Walter S. Johnson Foundation to support its work over the past several years and they have both expressed interest in future funding opportunities. Many of the ARCHES regions also have local private sources of funding that will engage with us on implementation locally and sustainability. ARCHES has worked closely with the private company, Daskala,, a networking software
company that focuses on creating tools for educators. The MDTP assessment tests have been integrated into the Daskala platform allowing for on-line current time review of student work. Daskala has expressed strong interest in working with ARCHES on this project. Daskala will contribute 2/3 of the cost of the tools to the work being proposed.

**Feasibility of Replication**

The feasibility of replicating this program in many settings with a variety of student populations is extremely high. The sites participating in this project were selected to represent a cross-section of districts, middle schools, and students in California, demonstrating geographic and ethnic diversity as well as district size. The interventions themselves do not require expensive technology, elaborate set-ups or increased resources, allowing for implementation within existing school structures. Further, at the completion of the grant, there will be a cadre of teacher trainers with expertise to train others in the implementation of the project with fidelity.

**Estimated Cost to Reach Students**

The cost per student of this project can be figured from three different perspectives: 1) The cost per student for the estimated 1,620 students served in three year study equals $2,647 per student; 2) Another perspective on the cost per student reflects not only on the cost/benefit for the target students in the study, but also the cost/benefit for all students taught algebra by these trained teachers during a five-year period; this equals $356 per student; 3) Because of the number of teachers added in the final expansion year, the cost/benefit per student to all students taught by the 78 teachers trained through the expansion years of the grant equals $108 per student. (See Appendix H for the formula to derive cost per student.)

**COST BENEFIT ANALYSIS**

<table>
<thead>
<tr>
<th>Based on cost per student noted above</th>
<th>100,000</th>
<th>250,000</th>
<th>500,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Start up target students $2,626 (3 years)</td>
<td>$262,600</td>
<td>$656,550</td>
<td>$1,313,000</td>
</tr>
<tr>
<td>2) All students of 18 teachers $360 (5 years)</td>
<td>$360,000</td>
<td>$900,000</td>
<td>$1,800,000</td>
</tr>
</tbody>
</table>
Mechanisms to Disseminate Information

Mechanisms to disseminate information on the project to support further development and replication will begin with the administering agency, the Round Table. The Round Table membership, consisting of the Chief Executive Officers in California K-20 education, provides direct and immediate access to educators and policy makers throughout California.

ICC/ARCHES, as a convener of statewide educational leaders, will share the results broadly across the state and nation. ARCHES has convened educational conferences over the past 5 years that have brought thousands of educators together around issues related to student achievement. Such conferences will provide a venue for presentations and reports to the leaders and faculty of all segments of education. Presentations will also be made to the California Mathematics Teachers, the Association of California School Administrators, National Association of School Principals, American Education Research Association, and the College Board and American Association of School Administrators conferences. We will disseminate the strategies through journal articles in publications such as Education Leadership, Kappan, Journal of Hispanic Higher Education (see Appendix C to view publications of project director) and other state and national venues. ICC/ARCHES will have reports available on the ARCHES websites and through the professional development programs at UC, CSU and in the K-12 and community college systems.

F. SUSTAINABILITY
The adequacy of resources to continue and expand this intervention is unsurpassed.

Resources and Support of Stakeholders

The power of the regional collaboratives which comprise ARCHES enables us to tap into a tremendous educational, business, and foundation network which will allow us to operate beyond the length of the grant, while the membership of the Round Table provides support from the education stakeholders at the highest level.
Incorporate Into Ongoing Work

The Round Table and ARCHES bring an established commitment to closing the achievement gap and a deep understanding of the critical role that success in mastering algebra plays in this issue. All of the entities that comprise the Round Table and ARCHES Collaboratives have a vested interest in the goals of this project. Further, the schools that have volunteered for this work have committed significant staff time because they recognize the potential solution for a problem that has long troubled them. Each school has agreed in their MOU to work with ARCHES to sustain the project at the end of the Development grant. (See Appendix D) These combined human resources allow for incorporation of the project activities into our ongoing work and that of our partners at a state, regional and local level.

- State: Provide incentives and professional development resources for schools prepared to implement the intervention.
- Regional: Utilize the ARCHES P-16 collaboratives to disseminate information, support the implementation of the intervention and leverage business partnerships. The regional P-16 collaboratives have tremendous capacity to use successful data and resources to garner funding from local, private and public sources as demonstrated by the continued support of The James Irvine Foundation and the Noyce Foundation.
- Local: Utilize the corps of highly trained teachers in a trainer-of-trainers model to support the diffusion of the intervention to other middle schools within the district and county

G. QUALITY OF THE MANAGEMENT PLAN AND PERSONNEL

We have an exceptional team from across several organizations that will oversee the work of this project. (See Appendix H Organization Chart.) The team draws upon its experience in working together on a number of efforts described in the grant.

This project will be carried out under the auspices of the California Education Round Table Intersegmental Coordinating Committee overseen by Dr. Penny Edgert, the Principal Investigator, who brings her skill at fiscal and reporting oversight to the grant. Dr. Edgert has a Ph.D. from the University of Chicago in Educational Measurement and Statistical Analysis and
has been the Director of the Intersegmental Coordinating Committee, the operational arm of the California Roundtable of Chief Executive Officers. The Project Director will report to Dr. Edgert. (See Appendix C for resumes of all key personnel.)

An Advisory Panel made up of distinguished members of the STEM community including mathematicians, scientists, math teachers and experts in working with English Learners and families will meet two times per year to advise and review our work. (See Appendix C for list of members and resumes)

The ARCHES Director, Dr. Diane Siri, will contribute her expertise and K-12 relationships in overseeing the leadership of the project at the 6 sites. She currently directs the Irvine Foundation-funded Linked Learning grant. Siri is a former County Superintendent of Schools, principal, and high school mathematics teacher with a Ph.D. in Education from Columbia University. She has extensive experience in starting innovative programs in mathematics. Her responsibilities will be to work with school site leaders to accomplish the grant goals, convene the Advisory Board and to coordinate with ConnectED on the professional development for teachers. Her 20% time will be an in-kind match funded by private sources.

The Project Director, Dr. Carrol Moran, and the budget analyst/operations coordinator will oversee the day-to-day work of the project, including recruitment of teachers and development of the summer and after school programs. The Project Director will report to the ARCHES director and be responsible for budget, staff, and oversight of the grant. The Project Director will also oversee the online coaching by Dr. Ivan Cheng, the college readiness component, the professional development for teachers on English Learners, and College Readiness, and she will oversee the family involvement. Dr. Moran brings a strong background with a Ph.D. in Education from Stanford, an M.A. in Mexican American Graduates studies, twenty years experience teaching English Learners, and fourteen years as Executive Director of a Partnership Center administering academic preparation programs at the University of California Santa Cruz where she managed 72 staff and 120 student employees. In her oversight of UC’s statewide summer algebra preparation Moran has developed a clear vision of the importance of
each of the components of the approach proposed in this grant and is experienced in all areas of the grant. (See Appendix C)

ConnectEd Director of Curriculum, Dr. Paula Hudis, will oversee the sub award to ConnectEd, and the curriculum and professional development including project management, budgeting, and coordination with ICC/ARCHES. For the past 4 years, Dr. Hudis has managed ConnectEd’s curriculum development work, including development of project-based curricula in engineering, pre-algebra and Algebra I. She holds a Ph.D. in sociology and demography from the University of Michigan.

Khanh Bui, author of the project-based curriculum, a credentialed math teacher, will be responsible for providing curricula for all three components of the project and managing and delivering the in-person and web-based professional development to teachers. Ms. Bui is a former math teacher at Berkley High School, where she participated in the Revitalizing Algebra project in collaboration with San Francisco State University and the National Science Foundation, and helped to open the Social Justice and Ecology small learning community.

Dr. Ivan Cheng will provide the webinar based coaching. Dr. Cheng is a professor in the Eisner Education School at California State University Northridge. Dr. Cheng has extensive experience as a secondary mathematics teacher and coaching teachers on teaching algebra.

We will also pay a stipend to a lead teacher at each school site to manage onsite activities.

**5-Year Project Management Plan [Bold print connotes major milestones.]**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Major Activities/Major Milestones*</th>
<th>Person(s) Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Attend kick-off meeting in D.C.</strong></td>
<td>Executive Project Team</td>
</tr>
<tr>
<td></td>
<td>Create subcontracts for partners</td>
<td>Project Director</td>
</tr>
<tr>
<td></td>
<td>Hire Staff</td>
<td></td>
</tr>
<tr>
<td>Time Period</td>
<td>Major Activities/Major Milestones*</td>
<td>Person(s) Responsible</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>Convene project teams and Advisory Board</td>
<td>ARCHES Project Director, ConnectED Curriculum Director, WestED Evaluation Director</td>
</tr>
<tr>
<td></td>
<td>Hold Launch meetings with all stakeholders</td>
<td>Project Director</td>
</tr>
<tr>
<td></td>
<td>Confirm match funding support</td>
<td>Project Director</td>
</tr>
<tr>
<td></td>
<td>Design and develop all products for professional development and webinars</td>
<td>Director Curriculum, ConnectED</td>
</tr>
<tr>
<td></td>
<td>Convene school partner leadership</td>
<td>Project Director</td>
</tr>
<tr>
<td></td>
<td>Develop support at each site</td>
<td>ARCHES Director, School/district leaders</td>
</tr>
<tr>
<td></td>
<td>Develop college readiness program</td>
<td>Project Director</td>
</tr>
<tr>
<td></td>
<td>Recruit teachers (target/control)</td>
<td>Schools’ site coordinators</td>
</tr>
<tr>
<td></td>
<td>Deliver 1st PD for Summer Bridge Prog.</td>
<td>ConnectEd, Khanh Bui</td>
</tr>
<tr>
<td></td>
<td>Set up logistics for summer program</td>
<td>Program Director/Schools</td>
</tr>
<tr>
<td>Winter 2011</td>
<td>2nd PD for Summer Bridge Program</td>
<td>ConnectEd</td>
</tr>
<tr>
<td></td>
<td>Recruit students, assign groups</td>
<td>Site coordinators and evaluators</td>
</tr>
<tr>
<td>Spring 2011</td>
<td>Pre-assess students (both groups)</td>
<td>Site coordinators and evaluators</td>
</tr>
<tr>
<td></td>
<td>Launch parent component</td>
<td>College Readiness team</td>
</tr>
<tr>
<td></td>
<td>Deliver Summer Bridge Program at six</td>
<td>Summer School</td>
</tr>
<tr>
<td>Time Period</td>
<td>Major Activities/Major Milestones*</td>
<td>Person(s) Responsible</td>
</tr>
<tr>
<td>-------------</td>
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<td>-----------------------</td>
</tr>
<tr>
<td>Summer 2011</td>
<td><strong>school districts</strong></td>
<td>Administrators and ConnectEd</td>
</tr>
<tr>
<td></td>
<td><strong>Provide PBL Algebra I PD and coaching</strong></td>
<td>Khanh Bui and Dr. I. Cheng</td>
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<tr>
<td></td>
<td><strong>Launch college readiness component</strong></td>
<td>College readiness counselors</td>
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<tr>
<td></td>
<td>Assess students for eligibility to extended-day “Math Lab” program</td>
<td>Teachers</td>
</tr>
<tr>
<td></td>
<td>Recruit eligible students for extended-day “Math Lab” program</td>
<td>Site principals</td>
</tr>
<tr>
<td></td>
<td><strong>Launch Extended Day “Math Lab”</strong></td>
<td>Site principals and coordinators</td>
</tr>
<tr>
<td>Fall 2011</td>
<td><strong>Launch PBL Algebra I</strong></td>
<td>Site principals and coordinators</td>
</tr>
<tr>
<td></td>
<td><strong>Provide follow-up teacher PD/Coaching for PBL Algebra I</strong></td>
<td>Khanh Bui and Dr. I. Cheng</td>
</tr>
<tr>
<td></td>
<td>Recruit additional teachers;</td>
<td>Site principals, leads</td>
</tr>
<tr>
<td></td>
<td><strong>Train for Summer Bridge Program</strong></td>
<td>ConnectEd</td>
</tr>
<tr>
<td></td>
<td><strong>Provide training on EL strategies</strong></td>
<td>Project Director</td>
</tr>
<tr>
<td>Winter 2012</td>
<td><strong>Recruit students and control group</strong></td>
<td>Site leads</td>
</tr>
<tr>
<td></td>
<td><strong>Provide follow-up PD/Coaching for PBL Algebra I</strong></td>
<td>Khanh Bui and Dr. I. Cheng</td>
</tr>
</tbody>
</table>

(See Appendix H for subsequent years.)

The ARCHES Project Director and ConnectED Curriculum Director will work closely with the WestED team who will direct and implement the evaluation design. The Advisory Board will review all of the work of the group and make recommendations on direction of the project. The sharing of formative feedback and creation of annual reports will be a collaborative
process between the evaluation team, the Project Director, and the Connect Ed Curriculum Director. The P.I. will have oversight over the entire process and rely on the Project Director to provide the oversight of the operation.

**Conclusion**

There is a clear need for new approaches that will increase the proportion of high-needs, under represented students meeting rigorous standards in algebra in 8th grade and entering STEM pathways. While summer algebra academies have been tried with some success, our model is unique in that it combines the best strategies from a number of previously successful endeavors: early intervention, rather than remediation; engaging, project-based learning; explicit strategies for English Learners; introduction to college culture for high needs students; and support for teachers through professional development and reflective coaching via web based technology. We believe that this constellation of activities will prove to be a uniquely successful approach that can be replicated and scaled to create success for thousands of high needs students in algebra.

Our driving motivation is our students and the telling results they have already demonstrated. A stellar example is a middle school Latina in Southern California who was failing in math. She was encouraged to enroll in a summer pre-algebra program that included a ConnectEd-developed project. The project required applying the algebra concept of calculating an appropriate slope to design a wheelchair ramp. Ratios, proportions, slope — suddenly, these abstract concepts had a new relevance for her. Instead of seeing herself pushing patients in wheelchairs up the ramp like the one at the nursing home where her mother works, this student saw that she could design the ramp itself. Before the class, she aspired to be a nurses’ aide. Today, she aspires to be an engineer. This true story is the choice we hope to create for thousands of students through this project.