Collaboration Resulting in Educators Applying Technology Effectively

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Collaboration Resulting in Educators Applying Technology Effectively

California State University, Northridge (CSUN), in collaboration with three school districts and a local charter school, proposes to develop and evaluate the **i3 Collaboration Resulting in Educators Applying Technology Effectively (CREATE) Project** to improve student achievement through the use of technology in implementing the Common Core State Standards in Mathematics (CCSSM) [*Absolute Priority 5, Subpart (b)*]. Specifically, we plan to support teachers—both pre-service and in-service—in creating learning activities aligned with CCSSM through the use of a tablet-based application (“app”) developed specifically for this project and supported by structured teacher collaboration.

A. SIGNIFICANCE

A.1. Addressing Absolute Priority 5(b)

New college- and career-ready content standards, such as the Common Core State Standards for Mathematics (CCSSM), present an unprecedented opportunity for pupils to engage in a rigorous and sophisticated conceptual understanding of mathematics. These new standards require pupils to go beyond basic mastery of procedures to engage in critical thinking and analyses of relevant information to solve rich problems—skills that are vital for success in college or careers. Unfortunately, the current instructional practices of many American math teachers align poorly with the demands of the CCSSM and instead emphasize explaining and demonstrating procedures—the kind of teaching these teachers themselves experienced as pupils (Hiebert, Morris, & Glass, 2003; Lampert, 1990; Smith, 1996).

This misalignment between the demands of the new standards and current teaching practices also poses a huge problem for teacher-preparation programs, which require in-service teachers to mentor pre-service teachers in teaching the new standards. Research has shown that, within the teacher preparation process, the experience that has the greatest impact on pre-service teachers’ practice is student teaching (Cavanagh & Prescott, 2007; Cooney, 1999), with mentor
teachers playing a most influential role in that experience. The problem of mentor teachers not modeling standards-based instructional practices is compounded by the fact that most teachers—even the most effective ones—are often not adequately prepared for taking on the role of a mentor (Sudzina, Giebelhaus, & Coolican, 1997). As a result, pre-service teachers have limited opportunities to rehearse practices that are aligned with CCSSM in their licensing programs. A study of recent math-credential graduates (Gainsburg, 2012) further suggests an inability of new teachers to transfer what they have learned in their pre-service coursework into the classrooms where they teach. Only practices that they had rehearsed in student teaching stood a chance of being implemented in their current classrooms.

In order to help pre-service teachers and their mentors engage in teaching practices that align with the CCSSM, we have developed an easy-to-use technology-based tool to help build their efficacy in implementing these practices. However, having this tool alone is not sufficient. Teachers also need to be able to reflect on their practice—and on the formative feedback from their pupils—in order to make the right choices about instructional materials and pedagogy. Such reflective practices work best when supported by collaboration and support from colleagues. Hence, our intervention for improving math education will focus on providing a structure to engage teachers in collaborative inquiry around the immediate learning needs of their pupils while leveraging the dynamic capabilities of technology to help teachers implement the CCSSM.

With an overall purpose of improving pupil achievement, CREATE will focus on supporting both in-service teachers and pre-service teachers in applying research-based practices to implement the CCSSM. A major emphasis of this project will be on providing professional development to strengthen the knowledge and skills of current in-service teachers so that they can meet the learning needs of all their pupils and provide high-quality mentoring for the next generation of teachers. Furthermore, CREATE will evaluate the linkages between the implementation of this project and pupil learning and use those data for iterative program improvement beyond the funding period of the grant.
A.2. Novel Approach

*Effective use of technology.* A key innovation of the CREATE Project is the use of a tablet-based application (“app”) that will be developed specifically for this project to support teachers—both pre-service and in-service—in designing and implementing lesson activities for CCSSM. Often, teachers who are accustomed to teaching from textbooks lack efficacy in developing innovative lessons from scratch. In order to reconsider what and how they are teaching, teachers need a tool that can help them create activities that will provide the depth of knowledge required by the CCSSM. Therefore, we envision the use of our discovery-learning app as a practical tool that can help teachers develop lesson activities and transform how they teach mathematics.

The features of our discovery-learning app are derived from extensive work over the past few years by teams of teachers participating in previous grant funded projects at CSUN. From these projects, teachers have developed a large number of course materials aligned with the CCSSM. In one study, the use of these pencil-and-paper activities suggested statistically significant positive results in pupil achievement and in closing the achievement gap between ethnicities (Cheng, Gainsburg, & Schlackman, 2013). At the same time—and perhaps even more important—these lesson activities affected the instructional practices of the teachers themselves. Because of the successes of these teacher-created lesson activities, we believe it is advantageous to leverage the dynamic and interactive capabilities of current digital tablet devices and convert our powerful paper-and-pencil activities into a tablet-based application that can facilitate teachers’ efforts and improve their efficacy in implementing CCSSM with real-time assessments.

It is important to note that the app we have designed is *not* a digital textbook. Typical “e-books” provide static images of the print page with links to videos or tutorial notes.
The design of our app is also distinctly different from a plethora of online tutorial programs that simply focus on mastering procedures and from other interactive resources such as Geogebra, Desmos, or ExploreLearning.

**Supporting changes in practice.** Implementing the CCSSM will require teachers to plan, organize, and implement learning activities that facilitate pupils’ own construction of knowledge; and it requires a constant application of professional knowledge—from intentionally sequencing specific examples to explain a concept, to assessing the pupils’ understanding of the concept, to responding to the learning trajectories of the pupils. This sophisticated application of teaching knowledge is not easily accomplished without some form of ongoing, structured support. Thus, our novel approach combines the use of the app with a structured form of collaboration that we are calling the Responsive Teaching Cycle (RTC), which will simultaneously blend the clinical experience for student teachers with the professional development of their mentors (Cheng, 2010).
RTC’s theory of change draws on research that suggests “teachers learn well just as students do—by studying, doing and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see” (Darling-Hammond, 1999, p. 12). Historically, attempts to improve teaching practice have focused largely on improving teachers’ content knowledge alone, or knowledge of teaching strategies alone, rather than on integrating and applying these bodies of knowledge in real classroom settings. In contrast, RTC supports teachers in applying mathematics knowledge for teaching (MKT) (Hill & Ball, 2004; Hill, Rowan, & Ball, 2005) through ongoing professional learning. As a form of job-embedded PD, RTC provides a structure for teams of teachers to plan lessons and formative assessments daily, weighing various options and making decisions based on the observed learning needs of their pupils. RTC uses teachers’ own classrooms—in summer school as well as throughout the year—as laboratories for engaging in a “plan-do-check-act” cycle of inquiry (Wilms, 2003) that informs and is informed by teachers’ increasing knowledge of pupil thinking.

It should be noted that the RTC approach focuses on collaborative lesson planning around immediate analyses of pupil thinking, unlike “lesson study” activities which typically involve periodic meetings that focus on polishing one particular lesson over some extended period of time. Teachers’ discussions of content and pedagogy are frequently driven by their need to produce the next day’s learning activities. Concreteness and immediate applicability of teacher discussions have been shown to be most effective in supporting teacher learning and improving pupil achievement (Berry et al., 2011). And because RTC empowers teachers with agency over their own learning process, they gain the confidence to take additional risks in trying new teaching methods (Loucks-Horsley et al., 2003).

A.3. Development and Advancement of Theory, Knowledge, and Practices

A central feature of the CREATE Project is that pre-service and in-service teachers are facilitated in using the app to design learning activities for pupils. As a result, teachers develop efficacy in thinking through their lessons, resulting in improvement in their teaching practices. Although RTC was initially conceived as a form of job-embedded PD for in-service teachers, its
educative potential for pre-service teachers seemed self-evident; so for several years CSUN placed small numbers of student teachers at schools employing RTC. These student teachers participated in RTC meetings as equal partners, sharing their observations of their pupils’ learning, contributing to analyses of pupil work, and co-planning upcoming lessons, activities, and assessments with a group of experienced teachers and other student teachers. In this manner, RTC established a data-driven community of practice, developing in student teachers the disposition to design instruction that elicited data about their pupils’ understanding and performance and that, in turn, addressed those data in responsive lessons. The power of this experience is demonstrated not just in the enthusiastic comments of the student teachers but also in the standardized test scores of their pupils, which exceeded school averages (see Appendix J).

The i3 grant represents an opportunity to systematically develop RTC communities of practice and promote the use of technology-enhanced instruction in more local schools, which will benefit teachers, their pupils, and future pre-service teachers placed at those schools. Our discovery-learning app, along with our model of structured teacher collaboration, would provide the tool and support that teachers will need in order to implement the CCSSM.

**Theoretical foundations for RTC.** Research is abundantly clear that teachers play a central role in the achievement of their pupils (Hightower et al., 2011; National Council for Accreditation of Teacher Education, 2010; Koppich, 2008). Equally clear is the effectiveness of teacher collaboration as a form of job-embedded professional learning (Berry et al., 2011; Franke, Carpenter, Levi, & Fennema, 2001). There is widespread agreement that effective professional learning occurs when the focus is on pupil learning (Guskey, 2003; Kennedy, 1999; Darling-Hammond, 1998) and connected to teachers’ own classrooms (Corcoran, 1995; Sparks & Loucks-Horsley, 1989). In one study based on a national evaluation of the Eisenhower Professional Development Program, researchers found that professional development closely related to the actual work of teachers is more likely to result in enhanced knowledge and skills. In addition, their data provided empirical evidence that collaboration and alignment of activities with the actual goals of teachers and schools resulted in changes in teaching practice (Garet et al., 2001).
**Theoretical foundations for the app.** One effective way to help teachers align their practice with the CCSSM is for them to use *guided discovery* in their lessons. Research has found that the use of “enhanced and/or assisted discovery” is more effective than other forms of instruction (e.g., direct instruction, unassisted discovery) (Baroody, Eiland, Purpura, & Reid, 2013; Alfieri, Brooks, Aldrich, & Tenenbaum, 2010). By using guided discovery, teachers can help their pupils observe patterns, make connections, and draw desired conclusions—skills that are aligned with the CCSSM and critical for pupil success in mathematics. Such an approach to teaching requires an extensive use of visual representations, which is one of the recommendations based on strong evidence in the Institute of Education Sciences (IES) practice guide for improving mathematical problem solving (Woodward et al., 2012). Visual representations “can produce learning gains that are difficult to achieve in other ways” (PCAST, 2010, p. 86). This is because “delays of as little as 20-30 minutes in displaying graphic data of an event occurring in real-time significantly inhibits the learning of the underlying concept” (Bransford, Brown, & Cocking, 2000, p. 179). Thus, a key feature of our proposal is an app tool that helps teachers design and implement learning activities that allow math visualizations in real time. Research suggests that the use of technology makes it possible for pupils to move flexibly between various representations (i.e., words, symbols, graphs, etc.)—a process that greatly enhances learning (Thornton, 2001; Lesh, Post, & Behr, 1987).

**Evidence of promise.** We have empirical evidence that suggests the potential for a positive impact of our proposed intervention (see Appendix D). While the discovery-learning app itself has not yet been programmed, the combination of the lesson activities upon which the app is based, along with the RTC process, have indeed led to **statistically significant positive results in closing the algebra achievement gap for Hispanic pupils**, with the treatment effects significantly greater than socio-economic factors, races, and even giftedness (Cheng, Gainsburg, & Schlackman, 2013).

**Potential impact.** The theoretical foundations, along with findings from our previous efforts, provide us with a reasonable expectation of improving mathematics achievement among a significant number of high-needs pupils. By combining RTC with the use of our discovery-learning app, we expect our project will lead to three key measurable outcomes.
(1) **Improved pupil-learning outcomes in mathematics.** Teacher collaboration is a powerful predictor of pupil outcomes (Berry et al., 2011). In fact, “a lion’s share of an individual teacher’s value-added gain to student learning, as measured by standardized test scores, was attributable to shared expertise” (p. 71). Based on the impact of RTC described in Appendix D, we expect similar or better results using RTC enhanced by a discovery-learning app. We expect teachers to be able to better engage pupils and address their immediate learning needs, thereby improving pupil-learning outcomes.

(2) **Course content and teaching practices aligned with the CCSSM.** Through the RTC process and the availability of the app tool, we expect the teachers—both in-service and pre-service—will generate their own collection of guided discovery lessons as well as new activities that are aligned with the CCSSM. Many of these learning activities will be implemented on tablet devices and can engage pupils in a dynamic, interactive problem solving experience. These lesson activities can also support learning for pupils well beyond those served directly in this project when they are disseminated to control teachers and others through conferences and professional networks.

(3) **Teacher professional learning is sustained.** The creation of guided discovery lessons, in itself, can be a powerful professional learning activity (Gerver & Sgroi, 2003). But because teachers’ beliefs and practices are also shaped by their experiences in the classroom (Loucks-Horsley et al., 2003; Thompson, 1992), the CREATE Project utilizes teachers’ own classrooms as the laboratories in which they can conduct “practical inquiry” and apply their professional knowledge. Such an inquiry approach, in a setting conducive to reflective practice, supports teachers in the “construction” rather than the “consumption” of knowledge (Little, 1993, p. 135; Sparks, 1994; Knowles, 1990). And, because teachers construct their own learning through practical experiences, they are more likely to continue using their newly acquired repertoire of lesson activities and teaching strategies and change the way they teach their pupils (Costa & Garmston, 2002a).

**Potential for scale.** RTC already has widespread support from various educational agencies, including the Intersegmental Coordinating Committee, which is currently implementing an i3-funded project that incorporates the use of RTC. And as one of the largest teacher preparation universities in California, CSUN is well positioned to build upon its success at increasing pupil
achievement in California public schools by further developing and bringing this intervention to scale. One key way that CREATE can impact teaching and pupil achievement at scale is through the preparation of additional high-quality teachers in mathematics. In doing so, CREATE will be able to inform the work of the Mathematics Teacher Education Partnership (MTEP), sponsored by the Association of Public and Land-Grant Universities (APLU), which serves 69 universities and 87 school districts across 30 states, as well as all 23 universities in the California State University system. Furthermore, the app itself can help sustain changes in practice as more and more teachers embrace the guided discovery approach for teaching mathematics. And with the increasing number of classrooms already equipped with tablets, the cost of providing the app would be minimal for schools in comparison with the cost of textbooks and other print resources.

**B. PROJECT DESIGN**

Our strategy for helping teachers improve their instructional practices addresses two common barriers experienced in many reform efforts: a lack of tools for implementing the reforms and insufficient professional support. Thus, we will use a two-pronged approach that is both innovative and exceptional: 1) teachers will be facilitated in their development of lesson activities through the use of our app and 2) they will be supported to rethink what and how they teach through a form of structured collaboration that has had demonstrated success in raising pupil achievement.

Second, our project design recognizes that support and professional development is critical to helping teachers implement new lessons and strategies. The Responsive Teaching Cycle (RTC) is based on research that suggests reflective practice is key to teacher improvement (Elmore, 2002; Kilpatrick, Swafford, & Findell, 2001).
B.1. Clear Goals and Outcomes

The major goals of our project are to improve pupil achievement in mathematics by helping teachers—both pre-service and in-service—develop lesson activities and shift their teaching practices to align with the CCSSM. This will likely be due to teachers’ increased capacity to address the learning needs of their pupils, as they focus on “getting through to the pupils rather than simply getting through a book.” Therefore, our specific measurable outcomes will show:

1. Pupils taught by treatment teachers will score significantly higher on new state standardized assessments than pupils taught by control teachers;
2. Treatment teachers’ course content and pedagogical practices are aligned with CCSSM as evidenced by the lesson activities that they design;
3. Treatment teachers will continue using RTC and the discovery-learning app beyond their treatment period.

Logic model. This proposal incorporates research-based best practices in teaching (e.g., the use of guided discovery) and strong theoretical foundations in the design of the RTC model.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSSM for content and math practices</td>
<td>Program, field-test and use app within RTC</td>
<td>Field-tested app</td>
<td>Pupils in treatment classes score significantly higher than pupils in control classes on state standardized test</td>
</tr>
<tr>
<td>Discovery-learning app wireframe</td>
<td>Conduct professional development on designing guided discovery lessons and the use of the app</td>
<td>Teachers from 3 school districts trained in RTC using the app (n=100)</td>
<td>Treatment teachers’ and student teachers’ lesson activities are aligned to CCSSM</td>
</tr>
<tr>
<td>RTC model</td>
<td>Implement RTC with the app during summer school</td>
<td>Student teachers from 3 school districts trained in RTC using the app (n=10)</td>
<td>Treatment teachers continue using RTC and app beyond their treatment year</td>
</tr>
<tr>
<td>Higher education/P-12 partnership</td>
<td>Implement RTC with the app during the academic year</td>
<td>New lesson activities and assessments aligned with CCSSM created</td>
<td>Student teachers in the treatment condition will have improved Performance Assessment for California Teachers (PACT) scores</td>
</tr>
<tr>
<td>Matching funds</td>
<td></td>
<td>Pupils from 3 school districts exposed to RTC trained teachers</td>
<td></td>
</tr>
</tbody>
</table>

Explicit plan. The CREATE Project will be implemented and studied in three phases. In the first phase, the discovery-learning app will be programmed and refined based on feedback from the pilot study. During this phase, a key focus will be on creating and solidifying the
structures for the implementation and evaluation of the intervention. This is necessary considering the complex regulations and processes that govern the various school districts involved. During this time, we will review and refine the professional development for using guided discovery in teaching and the discovery-learning app, as well as pilot-test the data collection processes and instruments used in the evaluation. Feedback from the teachers in pilot study will inform improvements for our impact study. Our formal quantitative data collection will begin in Year 2 with our impact study, once all of our systems are in place for implementation.

B.2. Key Project Activities

The implementation of the project consists of four key activities: (1) programming and refining the discovery-learning app, (2) professional development on the use of guided discovery and the discovery-learning app; (3) mentor teacher training, using summer school as a venue for learning the process of RTC; and (4) ongoing RTC during the school year with support.

(1) Programming the discovery-learning app. Instrumental in this project is the use of the discovery-learning app as a tool for teachers to help them develop lesson activities aligned with the CCSSM. While the design of the app has been completed, the programming still needs to occur in order to make it functional on tablet devices. The content developers, who are teachers that helped design the app, have spent extensive time developing the blueprints, or “wireframes,” for specifying the app’s appearance, functions, and behaviors. This work will be completed and field-tested prior to the implementation of the pilot study in the fall of 2015. Once the app becomes fully functional, it will be used by teachers to help them design lessons and also by pupils as they engage in those lessons. An essential element of the app is its ability to allow the user to define the contexts and parameters for various concepts. For example, if the lesson were to focus on proportional relationships, the user (i.e., teacher or pupil) can define the context (e.g., downloading songs, earning money, etc.) and the rate (e.g., 10 songs per day, $10 per hour, etc.) in order to explore the relationships between the graph, the equation, and tables of values for that relationship.

(2) Professional development on CCSSM and guided discovery. To support the use of the app, in-service teachers will first receive professional development in CCSSM aligned curricula and practices, particularly those that incorporate the use of guided discovery. At this
face-to-face training provided by the Principal Investigator and the content developers, teachers will be encouraged to use the app to organize content so that pupils can recognize and use patterns and themes for solving problems. This training will be learner-centered with the teachers doing mathematics themselves: solving problems, often collaboratively; presenting their work and examining the work of others; and justifying their solutions. Summaries of research will be provided to teachers as tools for guiding further discussions of how discovery learning can be implemented.

(3) **Mentor teacher training.** Successfully leveraging RTC to enhance the clinical experience requires skilled mentors. Mentor teachers will learn the process of RTC in the context of teaching summer school for pupils who have been unsuccessful during their previous year as 7th graders. During summer school, teachers will experience RTC as a situated apprenticeship (Wenger, 1998, Lave & Wenger, 1991) within a community of practice. Activities at these daily meetings will include writing reflections, collaborative assessment of pupil work samples, designing the next day’s lesson, and rehearsing new teaching strategies together. As a result, the mentor teachers will be able to experience what they will be asked to provide for their pupils during the academic year and to prepare for mentoring their student teachers more effectively.

Immediately before teaching summer school, mentor teachers will engage in two days of initial lesson planning, followed by daily meetings during the entire summer session. At the initial planning meeting, the teachers will work together in teams to plan out the scope and sequence of the courses they are about to teach. To help the teachers think differently about their approach for teaching their summer school classes, they will be provided the discovery-learning app that allows them to use guided discovery activities that are consistent with the principles CCSSM. In using the discovery-learning app, these activities can serve to illustrate the power of using patterns to develop generalizations and the importance of organizing concepts in order to make sense of the big ideas. More important, the activities will help the teachers recognize that working as a team can provide them additional insights and solution paths. In short, the mentor teachers will be able to experience what they will be asked to provide for their pupils and for their student teachers.

(4) **Ongoing RTC and professional development.** In this fourth key activity during the academic year, the teachers will continue collaborating in teams to further adapt instruction around
the learning needs of their pupils. Throughout the school year, RTC will be conducted at least once a week for 30 weeks, as in-service and pre-service teachers continue using the discovery-learning app to assist them in developing lesson activities. The key focus of these meetings is to brainstorm and create lesson activities or formative assessments in response to how pupils are learning.

An essential component of ongoing RTC is the use of skilled facilitators who can inspire vision and enable others to act (Wilson, Miller, & Yerkes, 1993). These facilitators will practice a blend of peer coaching (Showers & Joyce, 1996) that focuses on innovations in curriculum and instruction, and cognitive coaching (Costa & Garmston, 2002a, 2002b), which helps teachers improve their practice through reflection. To prepare additional facilitators for the intervention, teachers will be recruited from the pilot study and provided additional training in facilitation. By experiencing structured opportunities to apply their knowledge through RTC in the summer, the pilot teachers will learn how to serve as facilitators for the treatment teachers the following year. Institutionalizing this model can further help provide ongoing professional support for generations of new teachers.

**Strategies for mitigating risks.** Central to the success of the project is the fidelity of implementation of key components of this project. One potential risk to the project is inadequate support for the mentor teachers to ensure that they develop confidence and are afforded the time and resources to design and implement guided discovery lessons. To mitigate this risk, trained facilitators will provide ongoing collaboration with project teachers via Google Hangouts In addition, two retreats will be held each year to share best practices and provide professional development in mathematical knowledge for teaching (MKT). Site visits will also be conducted by the Principal Investigator to monitor the progress of RTC meetings that are supported by trained facilitators. A second potential risk is the lack of time to fully develop the app. To ensure that this risk is minimized, the programming of the app will be continuously refined over the project period. The Project Director will monitor the programmers subcontracted to write the code for the app. A contract will be provided to ensure that all contractual work is delivered on time and within budget. In addition, faculty from CSUN’s Department of Computer Science will be consulted to ensure quality control. And to provide technical support for teachers, an IT staff person will assist with downloading the app and other technical issues.
In addition, our evaluation plan includes the collection of process data to determine the extent to which the delivery of each component adheres to the design of our intervention. Based on the key activities of our project, we have identified the following indicators for monitoring this project:

- The attendance of treatment teachers in professional development for this project,
- The availability and successful implementation of summer school pilot,
- The amount of RTC training for teachers that will mentor student teachers,
- The number of hours treatment teachers are engaged in RTC during implementation,
- The amount of usage of the discovery-learning app by treatment teachers during implementation,
- The number, quality, and degree of CCSSM alignment guided discovery lesson activities created by treatment teachers.

The Principal Investigator and the Project Director will work with the External Evaluator to determine whether each project component is being implemented as planned. This team will operationalize each component in terms of observable indicators and the evidence needed to assess fidelity, as well as define what constitutes adequate implementation. The External Evaluator will then evaluate the fidelity of implementation at the both the component level and at the overall project level based on data across all of the components. Our plan’s milestones and measures will help provide a clear basis for monitoring and accountability and we have a Leadership Team (see following section) that will provide a feedback loop to drive ongoing work, monitor progress, and guide course corrections. Led by our External Evaluator, the Leadership Team will collect and review relevant evidence on a quarterly basis. The data collected will inform continuous program improvement throughout the project.

C. MANAGEMENT PLAN AND PERSONNEL

C.1. Timelines and Milestones

Implementation of the CREATE Project will occur over four years. In Year 1, operational aspects of the program will be put in place and a pilot study conducted to guide full implementation of the project. The treatment group will begin implementing the project in Year 2 with the control
group implementing the project in Year 3. Project activities will conclude in Year 4 with data analyses and reporting. Table 1 on p. 15 provides a summary of major activities and milestones.
Table 1. Summary and timeline of major activities.

<table>
<thead>
<tr>
<th>Major Activities/ Major Milestones*</th>
<th>Person(s) Responsible</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convene Project Team† and Advisory Panel</td>
<td>PI, Project Director</td>
<td>Winter 2015</td>
<td>Spring 2016</td>
<td>Spring 2017</td>
<td>Spring 2018</td>
<td>Annual reports</td>
</tr>
<tr>
<td>Hold launch meetings with districts and teachers</td>
<td>PI, Project Director</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Attended</td>
</tr>
<tr>
<td>Secure balance of matching funds</td>
<td>PI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Target met</td>
</tr>
<tr>
<td>Finalize research design and protocols*</td>
<td>External Evaluator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Completed</td>
</tr>
<tr>
<td>Recruit 10 pilot teachers*</td>
<td>Project Director, Districts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Target met</td>
</tr>
<tr>
<td>Program and refine discovery-learning app*</td>
<td>PI, Content Dev., Programmer</td>
<td></td>
<td>Spring 2016</td>
<td>Spring 2017</td>
<td>Spring 2018</td>
<td>App on iPads</td>
</tr>
<tr>
<td>Spring training retreat for teachers*</td>
<td>Project Director, PI, Content Developers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Retreat attended</td>
</tr>
<tr>
<td>Develop site support structures &amp; set up logistics for summer school</td>
<td>Project Director, Districts</td>
<td></td>
<td>Spring 2015</td>
<td>Spring 2016</td>
<td>Spring 2017</td>
<td>Implementation Kits</td>
</tr>
<tr>
<td>Recruit pupils for summer school*</td>
<td>Project Director, Districts</td>
<td></td>
<td>Summer 2015</td>
<td>Summer 2016</td>
<td>Summer 2017</td>
<td>30 per teacher</td>
</tr>
<tr>
<td>Design or revise PD for teachers</td>
<td>PI, Content Developers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PD handouts</td>
</tr>
<tr>
<td>Complete purchases of equipment &amp; supplies</td>
<td>Project Director</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>iPads purchased</td>
</tr>
<tr>
<td>Prepare Facilitators for RTC</td>
<td>PI, Content Developers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Trained Fac.</td>
</tr>
<tr>
<td>Provide CCSSM PD for teachers*</td>
<td>Project Director, PI, Content Developers</td>
<td></td>
<td>Summer 2015</td>
<td>Summer 2016</td>
<td>Summer 2017</td>
<td>5 days of PD</td>
</tr>
<tr>
<td>Implement summer school*</td>
<td>Project Director, Districts</td>
<td></td>
<td>Summer 2015</td>
<td>Summer 2016</td>
<td>Summer 2017</td>
<td>SS implemented</td>
</tr>
<tr>
<td>Implement summer RTC*</td>
<td>PI, Summer RTC Facilitators</td>
<td></td>
<td>Summer, Fall, &amp; Spring</td>
<td>Summer, Fall, &amp; Spring</td>
<td>Summer, Fall, &amp; Spring</td>
<td>20 hrs. logged</td>
</tr>
<tr>
<td>Fall training retreat for teachers*</td>
<td>Project Director, PI, Content Developers</td>
<td></td>
<td>Fall 2015</td>
<td>Fall 2016</td>
<td>Fall 2017</td>
<td>Retreat attended</td>
</tr>
<tr>
<td>Ongoing RTC during academic year*</td>
<td>PI, Facilitators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30 hrs. logged</td>
</tr>
<tr>
<td>Recruit 90 teachers (45 treatment &amp; 45 control) *</td>
<td>Project Director, Ext. Evaluator</td>
<td></td>
<td>Fall 2015</td>
<td></td>
<td></td>
<td>Target met</td>
</tr>
<tr>
<td>Ongoing data collection for fidelity and program improvement</td>
<td>External Evaluator, Project Director, PI</td>
<td>Summer, Fall, &amp; Spring</td>
<td>Summer, Fall, &amp; Spring</td>
<td>Summer, Fall, &amp; Spring</td>
<td>Summer 2018</td>
<td>Quarterly reports</td>
</tr>
<tr>
<td>Perform data analysis and prepare final report</td>
<td>External Evaluator, Project Director, PI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Final report</td>
</tr>
</tbody>
</table>

* Major milestones are marked in bold.
† Project Team consists of key personnel and Content Developers
Once teachers are randomly assigned to the treatment group, they will work together in clusters during the summer, based on their geographical proximity to one another. Thus, two or three teachers from four middle schools that feed into the same high school will work together during the summer to engage in RTC. During the academic year, these same teachers will share a common facilitator, who will provide ongoing support. Twice each year, all of the treatment teachers will convene as a professional learning community to share best practices and engage in professional development activities around research-based practices and mathematics content. In this manner, in-service teachers and their student teachers will experience ongoing support.

**Metrics for assessing progress.** Planned metrics will focus on processes and products that can be assessed for progress monitoring (Table 2 below). We will track and monitor the participation levels of the project personnel and the teachers as well as the products of their participation (e.g., created lesson materials). Records of attendance, meeting minutes and action plans, logs of app usage, and other quantitative data will be collected, along with qualitative data, such as surveys of pupils and teachers about their experiences with the app, and satisfaction with processes. In addition, the quality of the created lessons will be evaluated for their alignment to CCSSM.

Table 2. Summary of key deliverables for assessing progress for each category of participants.

<table>
<thead>
<tr>
<th>Types of Indicators</th>
<th>Project Personnel</th>
<th>Teachers*</th>
<th>RTC Facilitators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processes</strong></td>
<td>• Field testing of app completed by fall 2015</td>
<td>• Attendance at all PD (summer kick-off, fall retreat, spring retreat)</td>
<td>• Attendance at all PD (summer kick-off, fall retreat, spring retreat)</td>
</tr>
<tr>
<td></td>
<td>• Attendance at all project meetings</td>
<td>• Logged hours for RTC (minimum of 20 hours in the summer; min. of 30 hours per semester)</td>
<td>• Logged hours for RTC (minimum of 20 hours in the summer; min. of 30 hours per semester)</td>
</tr>
<tr>
<td></td>
<td>• School site visits (one per year per treatment school)</td>
<td>• Documented usage of the app (once per week for aligned topics)</td>
<td>• Reflection notes of RTC sessions documenting the topics of discussion and the products (e.g., lessons, activities, etc.)</td>
</tr>
<tr>
<td></td>
<td>• Attendance at weekly meetings throughout the project</td>
<td></td>
<td>• Survey responses for External Evaluators</td>
</tr>
<tr>
<td><strong>Products</strong></td>
<td>• Discovery-learning app revisions yearly</td>
<td>• Created lesson materials (two per week in the summer; one per month during the academic year)</td>
<td>• PACT scores for student teachers</td>
</tr>
<tr>
<td></td>
<td>• Lesson plans for app</td>
<td>• Lessons scored by rubric on quality and alignment with CCSSM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PD materials for RTC</td>
<td>• Survey responses for External Evaluators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PD materials for app</td>
<td>• PACT scores for student teachers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quarterly and annual reports completed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Teachers include both in-service teachers and student teachers.*
Annual performance targets. To monitor whether the project is achieving its goals, key project activities will have annual performance targets. Once recruitment goals are met, teacher attrition will be no more than 10%. Attendance at trainings and professional development activities will be at 100%, with make-up activities arranged for teachers who cannot attend. Participation in RTC will be set at 15 hours per summer and 30 hours per academic year. A total of 10 teacher-created lesson activity will be collected for analysis per year. The amount of app usage will vary, depending on the learning needs of the pupils. However, the target app usage is once per week.

C.2. Demonstrated Commitment and Broad Support

For this project, CSUN is partnering with three school districts and one charter school, with support from the California State University Office of the Chancellor, along with the Alliance for Regional Collaboration to Heighten Educational Success (ARCHES), and the Intersegmental Coordinating Committee (ICC) of the California Education Roundtable, which is a recipient of an i3 Development Grant from the first round of awards. Distinguished representatives from these partners will serve on our Advisory Panel to monitor the progress of the project and ensure its long-term success. Please see Appendix G for their letters of commitment and qualifications.

C.3. Ensuring Feedback for Continuous Improvement

Dr. Andrew Ainsworth, a researcher with over 15 years of experience in evaluation, will serve as the External Evaluator. With a strong background and experience in experimental research, comprehensive process and outcome evaluations, and complex data management and analysis, Dr. Ainsworth, is particularly well suited to provide ongoing feedback for continuous improvement in the implementation of this project. In addition to our External Evaluator, the Project Director will be the key person to ensure implementation success based on our detailed plan. Throughout the first year, the Project Director, the content developers, and the External Evaluator will meet weekly to refine the processes for the implementation of the pilot study and
the impact study. To ensure we have the capacity to drive progress, key personnel from the project team and the school sites will have specified roles to play (e.g., data collection, monitoring of participation, providing opportunities to participate).

Further, the Project Director will provide quarterly reports based on the data collected as evidence of the progress of implementation. These data will focus primarily on levels of participation and the fidelity of implementation. At the conclusion of the pilot year, a pilot study report will be provided based on formative feedback and recommendations for improving the app and RTC training. For the impact study, an interim report and a final report will be generated to provide details on the implementation of the project. All of these reports will be shared with the Advisory Panel for their review, feedback, and advice.

**C.4. Highly Qualified Personnel**

We have an exceptional team from across several organizations that will oversee the work of this project (see Appendix F). The team members draw upon numerous prior experiences that have prepared them for implementing the activities described in this proposal.

This project will be carried out under the leadership of **Dr. Ivan Cheng** as the Principal Investigator. Dr. Cheng has a bachelor’s degree in mathematics from UCLA and, in 1999, was among the first math teachers to be National Board certified in California. He earned his doctorate from UCLA, where he developed RTC under the guidance of Dr. Megan Franke. Dr. Cheng was recently the Principal Investigator of a $1 million grant from the California Postsecondary Education Commission (ITQ 09–607) for improving teacher quality to close the achievement gap using RTC. He is also co-PI for a $1.5 million National Science Foundation Teaching Fellowship Program grant (Project ID 4001395). In addition, Dr. Cheng is a lead developer for the i3 STEM Learning Opportunities Providing Equity (SLOPE) Project (U396C100135), overseeing the coaching component of the project. Recently, he was an invited presenter for two breakout sessions at the 2014 i3 Project Directors Meeting.
The Project Director, Jan Wood, M.A., along with a budget analyst/operations coordinator, will oversee the day-to-day work of the project, including recruitment of teachers and coordinating the logistics of the professional development activities, summer programs, and all stakeholder meetings. Ms. Wood brings a strong background with her experience as the Supervisor of Projects for the Stanislaus County Math Partnership, where she directed grant activities across 14 school districts and supervised employees at the Stanislaus County Office of Education. She has had 12 years of experience as principal and vice-principal for two school districts, and served nine years as Assistant Superintendent of Dos Palos Oro Loma Joint Unified School District, coordinating all functions of curriculum and instruction from Pre-School to Adult Education in the district. In addition, she has served as an adjunct professor at California State University, Stanislaus, where she taught graduate level courses for educators working on their administrative credentials. As the Project Director for CREATE, Ms. Wood will be responsible for the budget and oversight of grant implementation. She will also work with the External Evaluator to ensure fidelity of implementation of all project activities and compliance to all i3 guidelines.

Andrew T. Ainsworth, Ph.D. is Associate Director of the Center for Assessment, Research and Evaluation (CARE) and has 15 years of evaluation experience. Dr. Ainsworth has a background in quantitative psychology and is currently Associate Professor of Psychology at CSUN, where he teaches advanced research methodology (e.g., quasi-experimental design), multivariate statistics, latent variable models, measurement and psychometrics and recently an evaluation-centered action-research course. Dr. Ainsworth has co-authored articles related to his quantitative research methodology and evaluation work and he has worked as a statistical consultant on a number of large grants.

The programming of the app will be led by Dr. Mark Miller, Executive Director of Learningtech.org, a nonprofit dedicated to helping people use technology more effectively for learning. Prior to his current position, Dr. Miller, a graduate of MIT, worked at Apple for nine years as Lab Director, leading investigations of next-generation learning technologies within the
Advanced Technology Group. Dr. Miller also worked at Texas Instruments in educational applications. He holds a shared patent on “Graphical Interface for Interacting Constrained Actors.”

Finally, an Advisory Panel will work with the Project Director to review quarterly reports to monitor the progress of the project, provide feedback and advice on the implementation of the project, and assist with planning for sustainability and next steps. Members of the panel will also attend annual meetings to interact with the project team leaders to review our work in progress and provided feedback. This panel is made up of distinguished members of the STEM community, including representatives from education, business, and non-profit partners (see Appendix G).

D. PROJECT EVALUATION

D.1. Key Evaluation Questions

Key evaluation questions will be used to track project progress on milestones, key implementation activities, and objectives. To this end, we have designed a comprehensive formative and summative evaluation that incorporates the collection of both quantitative and qualitative data. The evaluation will utilize an experimental design (randomized control trial) to assess the program outcomes as well as to utilize process evaluation to provide continuous, ongoing feedback during the course of the program delivery. Outcome evaluation questions will assess the impact of the intervention on pupils and teachers. Process evaluation questions will be used to ensure fidelity of implementation and provide feedback for continuous improvement of the project, as well as determine lesson learned for further development and replication.

Outcome evaluation questions:
1. What is the impact of the intervention on pupil learning? Specifically, are the scores of pupils in classes taught by treatment teachers significantly higher than the scores of pupils in classes taught by control teachers on the new mathematics CCSSM assessment?
   a. What are the mediating variables relating the RTC training and discovery-learning app usage in treatment classrooms to increased pupil achievement as measured by the new CCSSM assessment (e.g., teacher rated pupil engagement)?
b. Are there moderators to this effect? Is the effect moderated by pupils’ demographics (e.g., gender)? Is the effect moderated by teachers’ demographics (e.g., years of service)?

2. To what extent does the intervention affect pedagogical practice?
   a. To what extent do teachers along with student teachers engage in RTC and use the discovery-learning app in their practice during the treatment year?
   b. To what extent are teacher-created lesson activities of treatment teachers better aligned with the CCSSM when compared to control teachers?
   c. To what extent do student teachers engage in practices aligned with the CCSSM based on their scores on the Performance Assessment for California Teachers (PACT)?

3. To what extent do teachers continue using RTC and the discovery-learning app beyond the treatment year?
   a. What barriers to implementation are identified and what are the lessons learned?
   b. What are the implications for sustainability?
   c. What are the implications for scaling up in the future?

**Sampling and experimental design.** For the pilot study in Year 1, 10 teachers will be recruited from the partner school districts to participate in the intervention (i.e., RTC training and facilitation along with access to the discovery-learning app via iPad). This pilot study will be used primarily to provide feedback for program improvement prior to the impact study in Years 2, 3, and 4. Furthermore, the pilot year will provide an opportunity to test evaluation procedures and instruments in the field prior to their launch for the actual impact study.

For the impact study in Year 2, 90 new eighth grade teachers (along with approximately 10 student teachers that are assigned to them) will be recruited from the partner school districts for participation in a randomized control trial. Teachers (both in-service and pre-service) will be randomly assigned to treatment and control groups (treatment ≈ 45 teachers + 5 student teachers; control ≈ 45 teachers + 5 student teachers) and compensated for their participation regardless of their treatment condition. Treatment teachers will participate in summer trainings related to RTC,
have ongoing RTC meetings throughout the academic year, receive a classroom set of iPads for use during instruction, and have access to the discovery-learning app. In Year 2, control teachers will teach their usual curriculum. Pilot and treatment teachers will be required to avoid sharing information and content with control teachers in order to avoid contamination between treatment and control conditions. In Year 3 project fidelity and impact outcomes will continue to be measured for the treatment group but treatment teachers will no longer receive RTC support while the control group will begin receiving the RTC summer training and support along with iPads. In Year 4, project fidelity and impact outcomes will continue for the control group but control teachers will no longer receive RTC support or facilitation.

All pilot teachers (N=10), treatment teachers (N=45 in Years 2 and 3) and control teachers (N=45 in Years 2, 3 and 4) will participate in surveys and focus groups. The External Evaluator will work closely with program personnel to recruit participation in surveys and focus groups; all responses will be confidential. Only the External Evaluator will have access to survey and focus group data; reports will only include aggregate summaries of data, and individual teachers will not be identified.

D.2. Evaluation Plan

The External Evaluator will work with partner school districts to acquire student-level math achievement test scores for all treatment and control teachers during the intervention study (N=90+10). We anticipate data will be analyzed using descriptive statistics, analysis of covariance (ANCOVA) and hierarchical linear regression to assess program impact and potential mediators and moderators. The minimum detectable effect size (f) for student outcomes across treatment and control conditions is .25 under the following assumptions: alpha=.05; site (school and district) and student-level covariates, such as prior test achievement (i.e., 7th grade scores) and demographics, explain 30% of variance in outcomes, and power is set at .80 (based on Cheng, Gainsburg, and Schlackman, 2013).

The structure of the project’s evaluation will be developed using a mixed-methods approach that utilizes both quantitative and qualitative methods. A logic model for the project
can be seen above and guides the evaluation (see page 10). A randomized between-groups experimental design will be utilized to answer outcome evaluation questions 1 and 2c. Student CCSSM assessment scores will utilized to compare the treatment and control group in Year 2 using both an analysis of covariance (ANCOVA; controlling for previous math ability and other demographic variables; e.g., SES) and hierarchical linear regression to address the degree of clustering effects within each class/teacher. The outcome of this set of analyses will indicate if the effect of RTC in improving math ability as found in Cheng, Gainsburg, and Schlackman (2013) can be replicated and/or improved when RTC is used in combination with the discovery-learning app. Additionally, we will compare Performance Assessment for California Teachers (PACT) scores for student teachers in the treatment and control using an independent samples t-test (or equivalent depending on the nature of the score distributions).

Additionally, in Years 3 and 4 we will utilize quasi-experimental non-equivalent groups designs along with hierarchical linear modeling to compare classes nested within teachers across the different treatment conditions (i.e., compare teachers in the control condition in Year 2 to the same teachers assigned to the treatment condition in Year 3) in order to test for the effect of RTC and the discovery-learning app while controlling for the contribution of the teachers themselves (i.e., outcome evaluation questions 1 and 3). This will also allow us to test for the sustainability of the RTC/app combination as a tool in these teachers’ classrooms and the impact on student assessment scores when no longer receiving direct support of the research team for the teachers in the treatment group (Year 3) and the control group (Year 4).

Finally, we will utilize descriptive statistics and qualitative methodology to assess 1) RTC and discovery learning adherence by teachers and student teachers, 2) discovery-learning app usage by teachers and student teachers, and 3) teacher and student teacher experiences throughout the treatment phases. Rubrics will be designed around the CCSSM standards as implemented through discovery learning in order to qualitatively assess how well new teacher-generated curriculum is aligned with the new standards as compared to control teachers. This will directly address outcome evaluation question 2. The discovery-learning app will
automatically collect data on app usage by teachers, student teachers, and pupils and this information will be used to assess outcome evaluation questions 2 and 3. Lastly, surveys, interviews, and focus groups concerning teacher and student teacher opinions (e.g., level of pupil engagement with math content, teacher mastery of new standards), and experiences (e.g., pupil success with math content) while receiving the treatment condition will be collected to assess outcome evaluation questions 1, 2, and 3.

D.3. Fidelity of Implementation

**Process evaluation questions.** To evaluate the fidelity of implementation, a number of formative/process evaluation questions will be answered. Thresholds for acceptable implementations will be determined based on results from the pilot study in Year 1.

1. Is there adequate program implementation and fidelity to the project design?
   a. How is the intervention implemented? To what extent is the intervention implemented as designed?
   b. Does the pilot study reveal sufficient discovery-learning app usage by teachers, student teachers, and pupils?
   c. Does the pilot study indicate app usability issues to be resolved before implementation?
   d. Are there any issues that arise during the implementation of the pilot program?
   e. Are appropriate participants (e.g., teachers, student teachers, pupils) selected for the study?
   f. Are teachers/student teachers randomly assigned to treatment and control conditions?
   g. Are treatment teachers/student teachers adhering to and implementing the program?
   h. Are teachers, student teachers, and pupils using the app regularly and consistently throughout the implementation of the project?
   i. Is cross-contamination between treatment and control teachers adequately prevented?

2. How satisfied are teachers and student teachers with the intervention?
   a. What are their perceptions related to its overall utility in the classroom?
   b. Are teachers, student teachers, and pupils in the study given adequate opportunity to provide feedback on the functionality and usability of the app?
3. What is the nature of collaboration among teachers and student teachers in RTC groups?

4. What are the challenges to implementation?
   a. How are barriers to implementation mitigated?
   b. What factors facilitated successful implementation?

In order to assess CREATE process evaluation questions we will also take a mixed methods approach. A variety of descriptive information will be collected from simple frequencies/proportions (e.g., types and number of teachers recruited, number of lesson plans created, app usage frequency) to simple averages (e.g., ratings of app usability and classroom utility, evaluator ratings of design implementation and teacher adherence) which will allow for the assessment of process evaluation questions 1b-i, and 2a-b. Qualitatively, we will analyze program documents and utilize questionnaires, interviews and focus groups with key stakeholders (e.g., teachers, student teachers, program administrators/facilitators) to assess the programs’ progress and to answer process evaluation questions 1c, 1d, 1g, 1i, 2a-b, 3 and 4a-b.

D.4. Sufficient Resources

The CREATE Project has budgeted 15% of requested funds to support the External Evaluator in carrying out the evaluation plan. This will allow the External Evaluator to provide ongoing reports of evaluation results during quarterly meetings with project staff. At these meetings, evaluation outcomes will be summarized and include the presentation of an overview of the project’s current progress, strengths, and a summary of recommendations for improvement. At the end of each project year, a written evaluation report will be submitted by the External Evaluator to the Leadership Team. The Evaluator will also work closely with the Principal Investigators to ensure that program design and evaluation activities are interrelated, and yield the most effective evidence-based outcome data possible. In summary, we will examine whether this intervention will significantly impact pupil achievement in an experimental study. We will also determine whether and to what extent this intervention facilitates teachers in engaging in practices that support the implementation of the CCSSM. Finally, we will evaluate the extent to which these professional practices are sustained once the treatment has concluded.
REFERENCES


