SITTE: A NEW MODEL OF PROFESSIONAL DEVELOPMENT TO ENGAGE TEACHERS IN DAILY COLLABORATIVE PLANNING AROUND EVIDENCE OF STUDENT LEARNING

This proposal seeks to develop, expand, and evaluate the effectiveness of an intensive professional development program for secondary mathematics teachers in Los Angeles Unified School District (LAUSD). Through this professional development program we seek to improve student achievement in algebra.

Algebra instruction has become critically important to LAUSD and many districts nationwide. Failure to pass algebra or an algebra based high school exit test has been identified as a primary cause of high attrition rates in urban high schools (Helfand, 2006; Viadero, 2005). Solutions to this problem have focused on improving teachers' content knowledge or knowledge of teaching strategies. However, most professional development efforts have done little to improve the quality of teaching or student achievement because teachers lack the time to engage in types of learning experiences that research suggests to be most effective (Ball, 2002; Stigler & Hiebert, 1999, Darling-Hammond, 1999). Thus, this proposal seeks to develop and evaluate a new professional development model in helping secondary mathematics teachers collaborate in rethinking and revising their teaching strategies.

Since 2004, LAUSD and CSUN have been engaged in developing a new approach to professional development called SITTE (Student Improvement Through Teacher Empowerment). In the SITTE model, teams of teachers meet each day after teaching algebra *during summer school* to conduct "practical inquiry" (Franke, Carpenter, Fennema, Ansell, & Behrend, 1998) facilitated by an instructional coach. In the daily meetings teachers are provided the time and resources that they need in order to engage in a thoughtful inquiry of their ongoing practices. In particular, this approach is based on the idea that teachers learn and grow by becoming problem solvers, rather than by being recipients of one-size-fits-all solutions generated by outside agencies. The SITTE model of professional development is also based on the Cognitively Guided Instruction model (Franke, Carpenter, Levi, & Fennema, 2001; Carpenter, Fennema, Franke, Levi, & Empson, 2000), which helps teachers organize their understanding of student thinking. As a result, teachers can examine the effectiveness of various strategies using data gathered from their daily teaching in order to make further decisions about instruction. In small pilot studies, the SITTE approach has impacted teacher beliefs and practices while substantially improving the pass rates of students enrolled in algebra classes.

We are proposing to further develop the SITTE program and to add support for teachers after the summer teaching and learning program with an interactive website called iSITTE. The website will help sustain the activities and practices developed during the summer project (a pilot version can be viewed online at http://algebra.teachercollaborative.net). The website will support the teachers during the SITTE training and then allow them to continue to collaborate with each other and their coaches throughout the school year. The website utilizes the latest tools for online community building (Barab, MaKinster & Scheckler, 2004; Renninger & Shumar, 2002) and provides resources specifically targeted for teachers in the program. The website will address the needs of the SITTE teachers, but it not be limited to workshop participants. We expect the website to become a resource for algebra teachers throughout Southern California.

The SITTE project will have a direct impact on a large number of students and a potential indirect impact on many more. The project will train over 100 algebra teachers in LAUSD (primarily middle and high school teachers in Local Districts 1 and 2). The schools in these local districts face the challenges of all urban schools—low SES students, many English language learners, and high dropout rates. Potentially, our project can impact the instruction of over 20,000 students over four years. There will also be indirect impact on other teachers who gain from using the iSITTE website, as well as from publications and presentations about the SITTE project. Our findings should be of great benefit to students and teachers in other districts where algebra failure is high and improvement in instruction is vitally needed.

A key goal for the proposed project is to conduct research to assess the immediate and long-term impact of the SITTE program on both the teacher practices and student learning. We will observe teachers periodically and analyze their lesson plans to assess their teaching approach. Because algebra instruction is highly standardized due to both state standards and district pacing guides, it is reasonable to compare (using observations and test scores) the SITTE teachers with other algebra teachers at their schools. Teachers who have participated in the SITTE training will be tracked to assess the pass rate for their algebra classes and the students' success on the exit exam. While this comparison is not a true experiment (selection of teachers for the program will not be random), we will use also pre- and post-test scores to compare the impact on student achievement. Further, we will collect data on how the teachers are participating and the extent to which they increase their pedagogical content knowledge and teaching skills. Ultimately this data will enable LAUSD and other districts to determine if the SITTE model of professional development should be expanded to more schools and more subject areas.

SIGNIFICANCE

A Crisis in the Classroom

Algebra has long been considered a "gateway" course to advanced mathematics and a pathway to postsecondary opportunities (ACT, 2005; Wu, 2001; Silver, 1995). In 2000, successful completion of first year algebra became a high school graduation requirement in California. Similar requirements also exist in many districts across the nation. However, statistics from Los Angeles Unified School District (LAUSD) indicate that as many as two-thirds of the students in first year algebra receive Ds and Fs (Ai & White, 2003). Failure to pass algebra or an algebra based high school exit test has been identified as a key factor in the high attrition rates of urban high schools (Allensworth & Easton, 2005; Viadero, 2005). A recent *Los Angeles Times* article quoted Los Angeles Unified School District (LAUSD) Superintendent Romer in saying that failure in algebra "triggers dropouts more than any single subject" (Helfand, 2006, p. A14). As a result, algebra is increasingly becoming a stumbling block, rather than a gateway, for students in accessing the knowledge and skills necessary to compete in the global economy.

At the same time, new understandings of how students learn mathematics are prompting many educators to reexamine how mathematics should be taught. Current reforms place a greater emphasis on conceptual understanding rather than mere acquisition of procedural knowledge (National Council of Teachers of Mathematics, 1991). However, most teachers are not adequately prepared to teach in this new way because they were taught in the very system they are now being asked to reform (Ball, 2003). Therefore, if teachers are to update their practices to align with the current goal of "teaching for understanding" (Carpenter, Blanton, Cobb, Franke, Kaput, & McClain, 2004), they will need extensive professional development (Chapin, 1994).

Teaching for Understanding

Because of the new emphasis on teaching and learning for understanding (Bransford, Brown, Cocking, 2000; McLaughlin & Talbert, 1993) teachers must shift the way they teach. This means, among other things, that teachers can no longer just "show and tell." Instead, they must create opportunities for students to make conjectures, test their hypotheses, and verify each other's conclusions. However, as Ball (1996) notes, "the impulse to help and clarify, to show and tell, is deeply rooted in teachers" (p. 504).

The practice of explaining and demonstrating procedures is something most algebra teachers have experienced as they watched and listened to their own teachers year after year (Smith, 1996; Lampert, 1990). As a result, teachers have well-developed "scripts" for how mathematics should be taught (Stigler & Hiebert, 1999; Borko & Livingston, 1989). The challenge of teaching for understanding, then, is to help teachers learn a *new* script for how mathematics should be taught.

> Teaching for understanding assumes substantial new learning on teachers' part; it requires change not only in what is taught but also how it is taught. Learning how to involve students actively in the construction of knowledge, how to move beyond fact-based concepts of knowledge and learner outcomes, and how to fashion new classroom roles and relationships involves more than simply sharpening up teaching skills or teachers' professional knowledge base as conventionally conceived. Teaching for understanding requires teachers to have comprehensive and indepth knowledge of subject matter, competence in representation and manipulation of this knowledge in instructional activities, and skill in managing classroom processes in a way that enables active student learning. (McLaughlin and Talbert, 1993, p. 2)

New Roles for Teachers

The new focus on teaching for understanding places teachers in the unfamiliar role of planning, organizing, and implementing learning experiences to facilitate students' own construction of knowledge. Rather than explain a comfortable set of rules, teachers must now help students see that "the problem is not the question and the answer is not the solution" (Lampert, 1990, p. 40). This means the teacher must guide students in discussions where the trajectory is uncertain and unpredictable (Ball, 1996; Lampert, 1990). Such an approach to teaching can make a teacher feel vulnerable and out of control (Smith, 1996).

In order to teach for understanding, teachers must take some risks to experiment with new ideas and strategies (Ball, 1996, Smith, 1996). They can do this by designing provocative problems, asking good questions, and letting the student struggle (Ball, 1996). Such an opportunity to choose appropriate problems can be extremely empowering if the teacher can anticipate the students' possible responses (Smith, 1996). This type of teaching is "learner centered" because the teacher's focus is on what the learner is thinking. Studies show that learning is enhanced when teachers pay attention to students' thinking. This means a teacher must determine a student's existing presuppositions and misconceptions as well as anticipate the students' possible learning trajectories. "They must be able to interpret the learners' comments, questions, and activities through the lens of a particular subject" (McLaughlin and Talbert, 1993, p. 3). This then indicates which tools might be most appropriate to use in teaching a particular concept and allows the teacher to go beyond mere transmission of information (Bransford, Brown, Cocking, 2000).

Knowledge That Teachers Need

Even though teaching for understanding requires an uncomfortable departure from traditional methods, the specific pedagogical tools can vary from lecturing to cooperative explorations. Just as a dance instructor must do "some telling, some showing, and some doing it with them" (Lampert, 1990, p. 58), a teacher must know when to let students ponder over a difficult problem and when to do some selective telling (Ball, 1996; Smith, 1996). The key to the teacher's effectiveness is her judgment about her choice of teaching strategies (McLaughlin and Talbert, 1993). Like an improvisational performer, the teacher must draw upon an extensive repertoire of moves (Borko & Livingston, 1989). It is this ability to know *what to do* and *how to do it* that allows a teacher to help students learn mathematics. This is what Shulman (1987) refers to as "pedagogical content knowledge," which is essentially a "cognitive roadmap" to guide the lesson activities and the questions asked (Bransford, Brown, Cocking, 2000, p. 155).

More recently, the work of Ma (1999), which examines the "profound understanding of fundamental mathematics," has led Deborah Ball and her colleagues at the University of Michigan to explore a more specific type of knowledge that mathematics *teachers* need (Ball, Hill, & Bass, 2005). In particular, this "mathematical knowledge for teaching" (MKT) represents a specialized knowledge of mathematical language, representations, and understanding of student thinking that goes beyond the knowledge of general pedagogical or mathematical skills. In studies exploring the relationship between the types of mathematical knowledge that teachers need and the achievement of their students, research suggest that an increase in MKT significantly predicts the size of student achievement gains (Hill, Rowan, & Ball, 2005).

Clearly, the work of teaching mathematics is extremely dynamic and complex; and it requires a constant application of professional knowledge—from sequencing the examples used to explain a concept, to assessing the students' understanding of the concept, to responding to the learning trajectories of the students. This demand for ongoing iterative decision-making is particularly challenging for algebra teachers who lack thorough knowledge in teaching mathematics. However, past attempts to improve the success rate of high school algebra students have focused largely on improving teachers' content knowledge alone, or knowledge of teaching strategies alone, rather than on integrating or applying these bodies of knowledge in real classroom settings. As such, many professional development efforts occur in the context of traditional "sit and get" or "go and get" workshops, which typically focus on transmitting a set of skills to passive learners (Sparks, 2002; Koppich, 2001, Darling-Hammond, 1999). Studies have shown that this common practice in professional development has made relatively little impact on changing teacher beliefs or improving their practices (Ball, Hill, & Bass, 2005; Garet, Porter, Desimone, Birman, & Yoon, 2001; Porter, Garet, Desimone, Yoon, & Birman, 2000; Little, 1993).

Transformative and Generative Professional Development

In contrast to the traditional "fill the empty vessel" model of many professional development workshops, researchers agree that the most effective types of professional development are *transformative* and *generative*. This means professional development must *change* teacher beliefs and practice as well as *enable* them to continue developing their MKT. Further, professional development must provide teachers opportunities to discuss, reflect, and develop and try out their ideas in an atmosphere of collegiality that is closely connected to the teacher's own classroom context (Lieberman, 1995; Guskey, 1994). In other words, teachers need to be involved in "the *construction* and not mere *consumption* of subject matter teaching knowledge" in order for their learning to be transformative (Little, 1993, p. 135).

Transformative learning occurs when changes in beliefs and practices take place (Sparks, 2002, p. 2-1). Transformative learning is also described as "emancipatory" or "empowering" because it gives the learner freedom to make choices regarding his or her own learning experience (Cranton, 1994). However, transformative learning is a difficult and painful process because it requires critical self-reflection. As the learner seeks to reconcile new ideas with past assumptions, there may be as much to unlearn as there is to learn (Ball, 1996; Cohen, 1990). Often, such a challenge to an individual's deeply held beliefs can result in the individual entrenching himself further in his prior beliefs and becoming hostile towards new ideas (Cranton, 1994). This common reaction to professional development efforts is often misinterpreted as teacher "resistance" (Fullan & Miles, 1992, p. 748). Thus, if professional development is to be transformative, teachers need a safe and secure environment in which they can re-examine their assumptions because learning often does require a radical change in attitudes and behaviors.

It's About Time

Substantial research exists to suggest that the most effective forms of professional development— those that change beliefs and practices *and* impact student learning— link what teachers are learning to their immediate classroom contexts (Loucks-Horsley, et al., 2003; Sparks, 2002; Cohen & Hill, 2000, 1998; Rényi, 1998). However, the current structure of most American schools do not afford teachers the time that they need in order to engage in the types of learning experiences—in particular, reflection and inquiry—which research suggests to be most effective (Ball, 2002, Darling-Hammond, 1999). In fact, the existing structure and culture of schools can actually hinder the professional growth of teachers (Elmore, 2002; Stigler and Hiebert, 1999; Lieberman, 1995).

The literature further suggests that one setting that can provide teachers the time they need in order to engage in reflection and inquiry *while they are actually teaching* is the traditional summer school or inter-session (Denton, 2002). During this time, teachers and students are not bound to the routines and constraints of the traditional semester. Typically, teachers have only one or two classes per day, similar to the regular schedule of teachers in Japan (Stigler and

Hiebert, 1999, Darling-Hammond, 1996). With fewer classes to teach (and a smaller student load), teachers would have more time to analyze their students' work. Stevenson and Stigler (1992) suggest that freeing teachers from the time demands of the traditional school day would give teachers the time to plan activities and reflect on their teaching. Research shows that generative change in teacher beliefs and practices requires an environment that allows teachers to think, discuss, experiment, and reflect (Swafford, Jones, Thornton, Stump, & Miller, 1999; Chapin, 1994; Little, 1993).

Student Improvement Through Teacher Empowerment

This proposal seeks to develop and evaluate an innovative professional development model (see Figure 1) that utilizes the teachers' own summer school/inter-session classes as a learning environment in which they can conduct practical inquiry as well as apply their own professional knowledge. Since 2004, LAUSD and CSUN have been engaged in developing such an approach to professional development, which we have named SITTE (Student Improvement Through Teacher Empowerment). Based on research that suggests teachers learn and grow the most from the "*construction*" rather than the "*consumption*" of knowledge (Little, 1993, p. 135; Sparks, 1994; Knowles, 1990), the SITTE model focuses on providing teachers the time and resources that they need in order to rethink and revise their teaching strategies.

Overview of the SITTE model for professional development:

Key principles:

- Professional learning situated in the context of teaching during summer school (or inter-session)
- Teachers collaborate to find ways to help *their* own students succeed in a clearly defined time frame with clearly defined goals
- Leverages teachers' knowledge as the starting point for creating solutions to *their* own problems
- Provides tools and resources without mandating strategies or curricula

Key processes:

- Plan-Do-Act-Check cycle of inquiry around an increasing awareness of student thinking
- Teachers explore, experiment, examine, and establish new strategies to "get through to students, rather than get through a book"

Key practices:

- Professional growth in four areas of teaching: *Planning*, *Implementing*, *Communicating*, and *Assessing*
- Teachers help students make sense of mathematics by organizing information to bring out patterns, using multiple representations, contextualizing abstract concepts, and connecting new concepts to students' previous knowledge

Other features:

- Aligned to district instructional guidance systems
- Teachers compensated for planning and teaching
- Collaboration facilitated by instructional coaches

Figure 1. List of features for the SITTE model of professional development

The literature suggests that job-embedded professional development is most effective in changing teacher practice and improving student learning (Franke, Carpenter, Levi, & Fennema, 2001; Kennedy, 1999; Rényi, 1998, 1996). Therefore, the SITTE professional development program uses a six-week long summer school or inter-session as the setting for professional development. Each day a team of teachers gather after teaching a morning class to review what had just happened in that class. At these daily meetings, an instructional coach facilitates a discussion to engage teachers in a "plan-do-check-act" cycle of inquiry (Wilms, 2003). Together, they examine student learning and student misconceptions and then explore possible ways to teach the next day. They also rehearse and experiment with new ideas for teaching, first in the meeting and later in their classes. Finally, they revise their lessons, refine them, and establish their repertoire of strategies. In this manner, the teachers are afforded the opportunity to develop their mathematical knowledge for teaching, within the context of an actual classroom.

One notable feature of the SITTE process is that it is based on an inquiry approach similar to that of the Cognitively Guided Instruction (CGI) model, which helps teachers rehearse new strategies and reflect on their own practices based on careful examinations of student thinking (Franke, Carpenter, Levi, & Fennema, 2001; Carpenter, Fennema, Franke, Levi, & Empson, 2000; Carpenter, Fennema, & Franke, 1996). In applying the principles of CGI, SITTE helps teachers examine the effectiveness of various strategies based on data gathered from their daily teaching in order to make further decisions about instruction. Research suggests that such an approach is generative, in that it allows teachers to experience ongoing improvement through analysis and reflection of practice (Kilpatrick, Swafford, and Findell, Eds., 2001).

The focus on student learning means that everything the teachers do—planning lessons, implementing mathematical tasks, communicating during instruction, and assessing student learning—is informed by and informs an increasing understanding of student thinking (see Appendix B). As a result, teachers are able to generate powerful guiding principles for their own teaching practice, such as using multiple representations or using patterns to help students make conjectures and generalize key concepts. Further, findings from a pilot study suggest that SITTE helps teachers develop their skills in asking effective questions, i.e., those that seek more than just the correct answer. This then leads them to become attentive, expectant, and responsive to possible trajectories of student thinking. In the process, the teachers develop flexibility and resourcefulness in adapting their lessons or in adjusting their teaching approaches (Cheng, 2005).

The SITTE approach provides a distinctly different, yet replicable model for effective professional development. With SITTE, learning comes from improvised practice rather than from a mandated agenda (Lave & Wenger, 1991). Because teachers see themselves as partners in the learning process, they become more willing to consider trying new strategies. Because SITTE empowers teachers to get through to their students rather than just getting through a curriculum, the teachers experience success with students. This, in turn, gives teachers the confidence to take additional risks in trying new teaching methods (Loucks-Horsley et al, 2003).

The results of the initial efforts with SITTE are promising and suggest that such an approach can impact teacher beliefs and practices substantially (Cheng, 2005). In two small pilot studies (N = 4 and N = 3 qualitative data suggest that teachers found themselves empowered to construct their own learning and experience transformative learning. During SITTE, they had the time to review their students' work, reflect on their teaching, and refine their strategies. And as the teachers continued to develop new strategies and lessons they also began to experience generative learning. For example, when asked about how SITTE affected him, one teacher replied, "My last three semesters here I was vaguely looking for something that I could use to help my students so they can go out of my classroom with something. But I just could not see how. Now I feel like I can make the difference." Another teacher reflected, "I grew as a teacher. I learned to value others' ideas, and most important, I learned what collaboration is about." These comments reflect the shifts in the teachers' beliefs and practices that subsequently affected how they delivered instruction in their regular classes. Research suggests such learning can have "strong carryover into the classroom" (Lockwood, 1998, p. 5).

Another outcome of SITTE is in student achievement. Students whose teachers participated in SITTE demonstrated improved scores on district, standardized assessments when compared with all students taking algebra at the same school. More notably, students in the classrooms of SITTE teachers passed algebra in significantly higher proportions than students from previous summer school algebra classes or classes from the regular school year (see Table 1).

Algebra 1A Classes (Regular v. SITTE)	Number of students enrolled	Number of students passing	Percentage of students passing
Spring 2004	418	106	25.36%
Inter-session 2004	131	51	38.93%
Inter-session 2005	95	28	29.47%
SITTE Inter-session 2004	**111**	**67**	**60.36%**
SITTE Inter-session 2006	**84**	**44**	**52.38%**

Table 1. Comparison of pass rates in algebra from the SITTE pilot studies

The data suggest that the effectiveness of SITTE can be measured, in part, by student outcomes in addition to analyses of teachers' practices. However, further research needs to be conducted to determine the nature and extent of SITTE's impact on teachers and students beyond the summer sessions. In particular, teachers who have participated in the SITTE training need to be tracked to assess the pass rate for their algebra classes and the students' success on district assessments. The details of the evaluation of SITTE will be discussed in greater detail in the Research Methods section of this narrative.

Sustaining Transformational Learning

Instead of just providing knowledge and skills to teachers, as many staff development workshops tend to do, the SITTE model of professional development is a process of transformational learning. In fact, it is an "experience of identity" (Wenger, 1998, p. 215) because "identity drives perception, choice, and behavior" (Costa & Garmston, 2002a, p. 70). Therefore, one of the key tasks of SITTE is to help teachers develop a vision for themselves, namely, an identity of being a quality teacher. This is accomplished by the use of facilitators, who 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.

Helping teachers reflect means SITTE facilitators must serve as "critical friends" who conduct focused observations in order to provide direct, honest feedback and critiques in a safe environment. Further, they are responsible for sharing ideas, research, and expertise during the SITTE meetings. This means characteristics such as trust and respect, working well with colleagues, and the ability to build skill and confidence in others are essential qualities of the SITTE facilitator (Norton, Greco, & Agee, 2002). Most important, SITTE facilitators must gain the legitimacy to lead by serving the needs of the teachers (Sergiovanni, 1992).

Clearly, an essential component of the SITTE program is the use of skilled facilitators who can inspire vision and enable others to act (Wilson, 1993). Currently, LAUSD already has implemented a coaching model as part of its District Mathematics Plan (DMP) (Ai, 2002a, 2002b, Ai & Marsh, 2004). These district coaches are experienced classroom teachers who are provided with additional content training as well as training in facilitation of professional development. Most serve in a full time, out-of-classroom capacity. Many are highly accomplished teachers who are respected by their colleagues. It is from this group that a small number of coaches will be selected to serve as SITTE facilitators.

Coaches who are selected to serve as SITTE facilitators will be trained during the summer alongside the teachers who are participating in SITTE. These coaches will be provided with protocols as well as summaries of research to ground them in the principles of the SITTE model. For three weeks, a team of facilitators will participate in daily SITTE meetings to help teachers hone their practice through collaborative examinations of student work and teaching practices. In this manner, district coaches can *experience* SITTE and receive their training based on a situated apprenticeship model (Wenger, 1998, Lave & Wenger, 1991). This use of district coaches will support and sustain SITTE, while enhancing the district's coaching capacity.

In addition to coaches facilitating SITTE meetings, we envision ongoing meetings between the coaches and the teachers from each coach's school who participate in the SITTE summer training. These meetings will occur as a part of the coach's regular duties, as well as during annual "reunions" facilitated by the principal investigators. Such meetings serve to provide ongoing support as well as an opportunity to collect data on the teachers' progress. Most important, ongoing meetings provide an opportunity to develop coaching capacity, as they practice their coaching skills in an organized setting. In this manner, the initial momentum gained from SITTE in the summer can be maintained to generate lasting effects.

Online Supports for Teachers

Despite its impact on teachers, SITTE is limited in much the same way as many professional development programs. Once the summer training is finished, teachers are generally left on their own to continue the practices developed during the training. District coaches can provide some level of ongoing support, but not nearly the amount of intensive and peer based feedback that teachers enjoy during the daily SITTE meetings. Maintaining the teacher contacts and getting instant feedback on teaching ideas can help maintain the momentum for reflective practice that is built up during the teaching and training during summer school. One effective way to provide connectivity between teachers outside of the SITTE meetings is to use the internet.

There are many websites designed for teachers, but most of these are the typical static websites designed to disseminate information. Many sites provide lesson plans and advice for working with students. The *Math Forum* (mathforum.org) is one of the best sites available for math teachers and an innovator for developing more interactive teacher supports (Renninger & Shumar, 2002). This site provides a huge collection of lesson plans, advice, reviews of curriculum and software, and a problem of the week for students at different levels. Many of the materials are suggested or contributed by teachers and other participants, but only after these materials have been reviewed and/or edited by the Math Forum staff. To provide a more interactive site, the *Math Forum* added the "Teacher2Teacher" section. Here teachers provide the questions and the answers on issues of math education. The interactivity of "Teacher2Teacher" allows the participants to form an online community and to take ownership of the site. This sort of website bears more resemblance to the SITTE model and provides the best supports for the teachers during and after the SITTE training.

In the last several years there has been increasing interest in online learning communities and, in particular, online communities of teachers. Online communities differ from the traditional website because the content of the site is largely created by the users rather than the administration. *TAPPED-IN* (tappedin.org) is one of the oldest and most studied online communities (Schlager, Fusco & Schank, 2002). For almost a decade, teachers of all types have been logging onto the *TAPPED-IN* site to talk with other teachers, exchange ideas and get help with problems. Dozens of schools, universities and other teacher organizations have decided to use *TAPPED-IN* as an online meeting and information exchange forum for their organizations. Another popular site, the *Inquiry Learning Forum* (*ILF*) (Barab, MaKinster & Scheckler, 2004) takes a different approach to online teacher communities. Instead of being all things to all teachers, the *ILF* defines the scope of the community around the idea of inquiry. They intend the site for teachers who are already or who are interested in using inquiry in their classrooms. This narrow focus allows the *ILF* website to be highly specialized for the goals of the program.

In all three of these examples (*Teacher2Teacher*, *TAPPED-IN*, *ILF*), as well as dozens more, the website becomes the locus of communication for the community. The website allows for multiple types of communication including instant messages/feedback, iterative discussion, collaboration on documents such a lesson plans. These features are exactly what are needed to support the SITTE teachers during and after the summer training. Teachers could start using the website regularly during the summer and then could continue into the school year. The online community would be able to provide peer support for teachers in looking at evidence of student learning to inform lesson planning.

The iSITTE website (see Appendix B) will address the needs of the SITTE participants, and be a resource for algebra teachers in general. Figure 2 describes some of the key features of the website. Many of these features are already created on our pilot website (http://algebra.teachercollaborative.net). This website takes advantage of the open source software for online learning communities. This makes it possible to put up a website with great functionality, yet with relatively little programming. To best meet the needs of the SITTE teachers some features need to be added to the current site. Modifications that we will make to the current website include building tools to support online discussion of math topics, such as ways for teachers to quickly input equations and graphs. We will also add ways for teachers to upload student work and videos of classroom interactions to form the basis for discussion of pedagogy situated in practice. Although the online discussion will never have the same level of interactivity as in-person discussion, there are some advantages to online communication, such as the use of multimedia and the creation of archives of all the discussions that teachers can reference.

Features of planned iSITTE website:

Resources for general public:
- Links to resources for algebra instruction
- Papers and videos of math teachers

Resources for registered teachers (including SITTE participants):
- Discussion board on algebra specific topics
- Information (links, lesson plans, student work etc) exchange
- Problem of the Month

Resources for SITTE participants:
- Class journal
- Planning team discussion board
- Working pages (wiki) to support planning activities

Resources for Researchers:
- Site registration includes informed consent
- Logs of all teacher activity and discussion on the site
- Poll and survey tools

Other features:
- Interactive tools for adding graphs and equations and sketches to the discussion boards and working pages
- Tools for uploading and comparing class averages on problem of the week
- Group tool which allows teachers to establish their own groups online in addition to their SITTE planning team

Figure 2. List of features for the iSITTE website

The iSITTE website is primarily intended for SITTE participants, but it will be have additional value if it is open to all math teachers. The SITTE teachers are will find greater utility if iSITTE is a dynamic community with many participants. Other teachers will benefit from access to the discussions and peer support as well. Teachers will be able to spread the work and communicate with peers who may not yet be part of SITTE. Allowing this gives teachers more ownership of the site and helps build community. Having the SITTE participants as core users of the website will help shape the online community around evidence based lesson planning. The community may also serve as an important mechanism for disseminating the teaching ideas in the SITTE model. We will identify the SITTE teachers when they log into the site and provide access to specific resources and discussions related to their work team. These SITTE team areas will remain private while the rest of iSITTE will be open for all teachers.

In addition to supporting teachers in their professional development, iSITTE will also support the research on the effectiveness of the SITTE program. The website will be able to log all the teacher actions, allowing us to identify profiles of teachers who are utilizing the web tools effectively and to notice possible correlations with student achievement. This internet site will also provide an efficient way to survey teachers about their teaching and pedagogy. While we intend to supplement our internet tools with paper instruments, online instruments can be more efficient and cost effective.

The use of iSITTE to enhance and extend the treatment of the SITTE program is a new approach to professional development. We expect that as we refine the online tools for supporting teachers that more and more teacher training programs will begin to utilize technology to extend the reach of their training. The research question for this aspect of the program is not "*Is this valuable?*", but "*How can we design the tools to maximize their value for teachers?*"

Goals of the SITTE Project

The combination of the powerful SITTE professional development and the iSITTE online community supports will provide an intensive and transformative experience for teachers. The first goal of this project is to refine the model and study its immediate and long term effects on teachers and their students. The proposed project has three specific objectives:

1) To develop and improve the SITTE model of professional development among urban secondary mathematics teachers in LAUSD,
2) To develop and evaluate web tools to support SITTE teachers, and
3) To conduct the first large-scale evaluation of the SITTE model for teacher professional development.

At the same time, SITTE is a collaborative effort between California State University Northridge and the Los Angeles Unified School District. Because LAUSD district is most interested in helping teachers shift their practice toward an emphasis on conceptual understanding and problem solving, a second goal of our proposal is to support the District Mathematics Plan (DMP) in their instructional objectives. In particular, we will promote the use of (1) multiple strategies in teaching that include inquiry based lessons, (2) multiple representations of algebraic concepts, (3) high cognitive demand tasks (Smith & Stein, 1998), and (4) questioning techniques that focus, rather than "funnel," student thinking (Herbel-Eisenmann & Breyfogle, 2005), as well as using questions to probe and extend student thinking (Boaler & Brodie, 2004).

As we explore the potential of SITTE, a third goal of this research proposal is to disseminate findings that would be useful for professional developers and school policy makers. Current budget limitations faced by districts across the nation could make SITTE a particularly attractive alternative to costly, but ineffective workshops.

Finally, by helping teachers focus on student learning, it is our goal that SITTE can help all students succeed in algebra. As a result, SITTE can serve as a means of helping more underserved students access educational and vocational opportunities.

RESEARCH METHODS

Research Design

The SITTE trainings will provide multiple opportunities for teachers to improve their knowledge of algebra and algebra teaching. The daily assessment and planning discussions provide a structured environment for teachers to look at students' work and apply what they learn to their teaching. We will assess the effect of the SITTE program on the teachers' knowledge of mathematics and pedagogy and how the program affects teachers' beliefs and practices.

Proposed Intervention. To develop and refine the SITTE model, we will implement this professional development for secondary mathematics teachers in LAUSD for four consecutive summers. Each teacher will teach a two-hour summer school class and participate in SITTE professional development immediately after teaching their morning class. The daily planning meetings will be facilitated by CSUN faculty and/or by district math coaches who have been trained in the SITTE process. Then during the school year, SITTE teachers and their coaches will meet on a regular basis to continue the collaboration that they had begun in the summer. Each year of the study there will be an increase in the number of teachers participating, as more coaches are trained to facilitate the trainings (see Table 2). The teachers will be introduced to the iSITTE website during the SITTE training and then continue to communicate online during the school year. Activity on the website will be monitored and occasionally facilitated by both coaches and CSUN faculty. In addition to discussions around the district's concept lessons and issues teachers are grappling with, we will also post periodic "Challenge Problems" to extend discussions on key issues and to support the type of reflective planning that has taken place during the summer.

Year	Teams	Teachers	Facilitators trained	Summer students	Students Impacted (following SITTE)
Summer 2007	3	12	8	360	1800
Summer 2008	6	24	8	720	3600
Summer 2009	9	36	8	1080	5400
Summer 2010	12	48	0	1440	7200
Total	**30**	**120**	**24**	**3600**	**18000**

Table 2. Estimates of the number of participants and students potentially impacted by SITTE (The estimate of 30 students per class and 5 periods per semester are likely underestimated.)

Proposed Research. We hypothesize that this SITTE implementation will impact the algebra teachers, their summer school students, and their students in future classes. Our research will attempt to identify the impact as compared to district algebra teachers who have not participated in SITTE. Specifically, we have six main hypotheses:

1. Students in summer classes taught by SITTE teachers will score higher on district and state assessments than other students in comparable classes.
2. Students in summer classes taught by SITTE teachers will successfully pass algebra classes at a higher rate than other students in comparable classes.
3. SITTE teachers will demonstrate behavior consistent with the principles of teaching for understanding (TFU), rather than teach for procedural fluency alone.

4. SITTE teachers will demonstrate a deeper understanding about their own instructional decisions and the mathematical thinking of their students.
5. The teachers who participate in the SITTE training and iSITTE online community will continue effective teaching practices after the summer trainings are completed.
6. Teacher practices and student scores will correlate with the extent to which SITTE teachers engage in the summer training and website activities.

In addition to testing the hypotheses described above, this study will also examine qualitative data on *how* teachers are developing in their capacity to provide instruction based on conceptual understanding and problem solving. Qualitative data will consist of surveys, interviews, and observations. Further, we will look at what types of teachers benefit most from SITTE. Web usage data will also be used to refine the web tools utilizing a design experiment methodology (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003).

Participants and Setting

Approximately 120 teachers will participate in the SITTE training (treatment group) in 30 different teacher teams over the four years of the program (see Table 2). Members of each SITTE team will be made up of teachers from the same school. Senior administrators from LAUSD Local Districts 1 and 2 will identify which schools will participate in the training. With several schools still under construction, District 1 will include 15 high schools and 15 middle schools with over 55,000 secondary students, while District 2 will include 8 high schools and 14 middle schools with over 46,000 secondary students. Together, Districts 1 and 2 cover a region of metropolitan Los Angeles known as the San Fernando Valley. With almost 2 million in population, the Valley would become the fifth largest city in the United States, if separately incorporated as a city. Minority students make up 77% of the student population in District 1, and in District 2, minority students make up 89% of the student population. Over 30,000 secondary students in the two districts are classified as English language learners. All but four schools out of the 52 secondary schools in Districts 1 and 2 are classified as Title 1. Finally, in LAUSD, the overall percentage of students receiving Ds or Fs in one-year algebra courses ranges from 44.7% to 63.9%, depending on the grade level of the students (Ai & White, 2003).

Contractual agreements require building administrators and department chairs to select teacher participants based on established district protocols. Since the sampling process will not be random, we will include pre- and post- measures for all teachers in the treatment and control groups. Participation in the training will require that teachers agree to participate in assessments that include the release of aggregate test scores for their algebra students (aggregate scores will not identify student's names, only a teacher identification code for tracking purposes). All teachers will agree to complete surveys and assessments as part of their participation in SITTE. A small number of the teachers (N=10/year) will be randomly selected to be observed and interviewed before, during, and after the summer training. These Observation-Treatment (OT) teachers will be given an additional stipend for participation in the interviews.

All non-SITTE algebra teachers at schools where SITTE is implemented will be considered as control teachers in terms of the student test scores and pass rates. Most secondary schools in Districts 1 and 2 have large mathematics departments (10 to 30), so the recruitment of control teachers will not likely be difficult. At the same time, the relatively small number of participants in the treatment group should not deny many teachers or students from the benefits of SITTE. This eliminates a potential ethical concern. Further, student data for control teachers will be aggregated so individual control teachers are not identified. A small number (N=10/year) of teachers will be randomly selected from the pool of control teachers for more in depth analysis with surveys, interviews and observations. Again, the teachers will be tracked by code to maintain their anonymity. Further, these Observation Control (OC) teachers will provide informed consent and be paid a small stipend for their participation in surveys and interviews, as well as for their willingness to be observed.

Measures

The data collected by LAUSD in its own internal evaluation of the District Mathematics Plan (DMP) consisted of teacher observations, interviews, and student performance data (Ai, 2002a, 2002b; Ai & Marsh, 2004). Therefore, we will build on this knowledge base and utilize similar measures for comparison purposes. Further, the participation of teachers in iSITTE, the online component of SITTE will be assessed and analyzed.

<u>Behavioral measures of teachers</u>. To measure the impact of SITTE on teacher practice, we operationalize the definition of teaching for understanding (TFU) as (1) knowing and teaching mathematical content using high cognitive demand tasks (Stein, Smith, Henningsen, and Silver, 2000; Smith and Stein, 1998), (2) giving attention to the selection and sequencing of tasks in lesson design, (3) knowing and using multiple representations and/or multiple strategies in teaching (NCTM, 1991), and (4) using questioning and assessment strategies that seek more than just the correct answer (Boaler & Brodie, 2004).

Some indicators for the behavioral changes that characterize TFU include (1) increased knowledge for algebra teaching, (2) increased awareness of student thinking and the possible trajectories of that thinking, (3) increased use of high cognitive demand tasks, (4) increased consideration of student thinking in the selection and sequencing of tasks in lessons, (5) increased use of multiple representations and inquiry based activities in teaching, (6) increased use of multiple strategies for lesson delivery beyond lecturing, (7) increased use of questioning techniques that focus and extend student thinking, and (8) increased use of assessments (formal and informal) to drive lesson design. In short, we are looking for evidence that teachers are thoughtfully designing instruction based on data about their students' thinking, rather than simply teaching through a textbook.

To determine the nature and extent that teachers demonstrate TFU, we will examine the above indicators in four areas of their teaching practice: *planning*, *implementing*, *communicating*, and *assessing*. We will examine the extent to which SITTE teachers demonstrate TFU practices in comparison to the practice of teachers in the control group, as well as comparisons of the SITTE teachers' practices before, during, and after participating in SITTE. In particular, we will compare the frequency and quality in the teachers' implementation of such teaching strategies.

To evaluate the nature and the extent of teachers' use of TFU strategies, we will use *surveys*, *interviews*, and *observations*. The surveys, interviews, and observations will provide answers that are both quantitative and descriptive in nature. We will also collect artifacts, such as lesson plans and student work samples, which will further enable us to triangulate our findings. Further, the iSITTE "Challenge Problems" will be posted to help us compare teachers' knowledge of mathematics and their consideration of student learning as they plan for implementation.

Surveys of teacher knowledge and beliefs:

- **Knowledge of Algebra for Teaching:** (KAT) assessment of mathematics content knowledge for algebra teachers (Burrill, Ferrini-Mundy, Senk, & Chazan., 2004)
- **Teaching Styles Survey:** (see Appendix B) assessment of teachers' pedagogical content knowledge (PCK) for algebra. This instrument is based on the RAND *Mosaic II Mathematics Survey* for grade 9 (Stecher et al., 2006). The survey includes questions about typical teaching situations to determine teacher attitudes toward reform type teaching practices consistent with TFU (Le et al., 2004)

Interviews

Teachers in the Observation-treatment (OT) and Observation-control (OC) groups will be interviewed before and after the summer training period. The purpose of this interview is to assess teachers' beliefs about their students' difficulties in algebra as well as their knowledge of student understanding of algebra. Further, we wish to determine the teachers' thinking process in lesson planning with specific questions to address their goals for instruction, the choice of strategies used in instruction, and the types of mathematical tasks presented. The interviews will further serve to clarify responses on the surveys and the classroom behaviors observed, such as the choices and rationale for teachers' questions and their responses to student questions.

Observations

Each teacher in the Observation Group (N=10/year) will be observed twice before, twice during, and twice after the SITTE workshop (six observations per teacher). Control teachers (N=10/year) will be observed three times before and three times after the summer training (six observations per teacher). Each observation will last approximated 45 minutes to one hour (i.e., one class period). Observations will be conducted by graduate student research assistants who have been trained in methods of data collection. Field notes will be collected to record (1) number of students, their gender and ethnicity; (2) math content and the cognitive demand of tasks; (3) teacher activity; (4) student activity; (5) classroom social environment; (6) interactions between teachers and students, and among students; (7) materials being used (e.g., textbook, handouts, etc.); and (8) where applicable, students' solutions to the problems and/or their thinking process.

Artifacts of Classroom Teaching

Teachers in the Observation-treatment (OT) and Observation-control (OC) groups will be asked to submit artifacts from their classroom including lesson plans for a specific topic, student work with feedback and classroom assessments (quizzes, tests etc). We will specifically collect artifacts around the preparation and feedback on the iSITTE Challenge Problem. These artifacts will be analyzed qualitatively to assess types of teaching practices.

Teachers do not all benefit from professional development in the same way. Some teachers may engage more in the learning process than other and thus be more likely to change their teaching practices. We will look at how the SITTE teachers participate in the program both during the summer training and then later their participation in the online activities on iSITTE. Participation in the summer trainings will be based on facilitators' notes and copies of the teachers' journals kept over the summer. Participation on the iSITTE website will be determined by the website logs. Teachers' online journal entries, communication on the discussion boards and working pages will provide detailed evidence of teacher's continued participation. Some teachers may continue the program without using the website. Post workshop teacher surveys will help to identify other ways in which teachers are sustaining the practices developed over the summer.

Student learning and achievement. Our hypothesis is that changes teacher practice as a result of participation in SITTE will correlate with improved student learning and success in algebra. We will use four primary measures of student learning: (1) district standardized assessments, (2) state standardized tests, (3) the pass rates of students in algebra, and (4) scores from district concept problem and our own "Challenge Problems." Students in middle and high school algebra courses already take a battery of standardized tests. We feel that the data already being collected is sufficient to meet the needs of this study. Adding more tests for the students would provide little additional data.

Every algebra student in LAUSD takes quarterly district assessments, an annual California Standards Test (CST), an annual norm-referenced standardized test (CAT/6), and the California High School Exit Exam (CASHEE) beginning in the tenth grade. Each of these exams, except the norm-referenced CAT/6, produces an algebra specific score designed to indicate the students' level of understanding of the material. We will use descriptive statistics, including hierarchical linear models, to compare student performances in these assessments. Test results will be disaggregated only to separate the teachers who participate in SITTE, in order to compare how their students perform relative to students in classes whose teachers do not participate in SITTE. No individual students will be identified. Comparisons will be made between SITTE and non-SITTE teachers in district test scores and grades for students in the same subject area during and following the SITTE professional development.

We will use a "value-added" approach to determine the gains made by students of the SITTE teachers, relative to their peers in classes taught by non-SITTE teachers. Analyses of this data will help us to determine whether there is any improvement in student achievement following teachers' participation in SITTE. Additionally, the district's constructed response problems in the quarterly assessments and our "Challenge Problem" will provide us with a particularly fine-grained comparison between SITTE teachers and control teachers. These problems will include a scoring rubric and suggested instructional activities. We will collect copies of student work, and classroom scores to gain a more detailed assessment of student problem solving in the different classes before and after the SITTE training. Again, no student identifiers will be used, other than a code to track the teachers.

Validity and Reliability. Comparison of standardized test scores is a widely accepted means of determining relative effects of a particular intervention. We are using, as one of our measures, tests that are currently validated in state level and district level assessments. The application of rigorous and commonly accepted statistical methods will further ensure the validity of our findings. Since we are expanding the sample size over the four years, we should be able to gather sufficient data to determine effects that are statistically significant.

Student grades, and specifically the pass rates for algebra classes, are also a key measure for our research. Although grades are not a validated measurement of student achievement, they are strong indicators of the teachers' mediational effect upon their students' performance. In fact, teacher practices are among the most significant factors affecting student achievement, including teacher assigned grades based on "point-in-time" tests (Wenglinsky, 2000). Improved grades in algebra, when correlated with higher achievement in standardized tests, should provide a degree of assurance that the impact of SITTE is not random and is suggestive of SITTE's potential for positively affecting student achievement. Further, increased pass rates will be correlated with process data to explore the elements of teachers' beliefs and practices that might be influential in improving student performance. This will be particularly beneficial for other districts that might be seeking alternative approaches to helping students succeed in algebra.

The primary limitation of the study is the lack of random sampling of teachers for the treatment condition. The selection by administrators seems unlikely to bias the sample for or against the treatment, but it is not possible to rule it out. We will address this by looking at pretest, pre-survey, pre-observation and student test scores from the year prior to the SITTE professional development. Having data that represent the teachers' (including OC teachers) attitudes, practices, and student achievement before the training will enable us to identify teacher growth and overall impact of the SITTE trainings.

The measures of teacher knowledge and practice are based on established measures and procedures. The KAT and *Mosaic II Teacher Survey* have both been extensively studied. The classroom observations will be made by trained observers using a common observation instrument (see Appendix B). The training of coders for the open ended questions as well as teacher interviews and observations will enable us to establish the reliability for this data.

Additional Process Data

In addition to testing the hypotheses described above, this study will also examine qualitative data on *how* teachers are developing in their capacity to provide instruction based on conceptual understanding and problem solving. At the same time, we seek to understand what are some affordances and hinderances of SITTE that might affect teachers' beliefs and practices. Such data is not readily quantifiable and the analyses would be highly interpretive. Even so, the risk of drawing invalid conclusions is less serious than trivializing the study into artificially quantified research questions (Maxwell, 1996).

Collection of process data will occur during SITTE training and in the school year following the training. The data we collect will include (1) an inventory of the teachers' knowledge of student thinking given before and after SITTE, (2) observation notes of teachers in their classes as well as in the daily discussions during SITTE, (3) written reflections from the teachers during SITTE, (4) observation notes from the teachers' classes after inter-session, and (5) post-SITTE interviews with the teachers about their attitudes and instructional choices. Process data will be coded for themes that emerge to determine patterns in teacher behaviors and attitudes. We intend to use the process data to see *where* and *how* teachers shift their thinking as a result of participating in SITTE.

Data Analysis Procedures

The analysis of the data collected on the SITTE and control teachers will be led by our statistics consultant, Dr. Christy Kim Boscardin of CRESST. She will work with the CSUN faculty in establishing the reliability of coders and preparing the data for hierarchical linear models (HLM) analysis. The data analysis plan is organized around six main study hypotheses.

1. Students in summer classes taught by SITTE teachers will score higher on district and state assessments than other students in comparable classes.

To examine the impact of SITTE program on student achievement, we will use hierarchical linear models (HLM) to compare student performance on the district and state mathematics assessments between students enrolled in SITTE teachers and comparison group teachers. HLM was chosen for the analysis for two reasons. First, when using data obtained from multiple classrooms, observations obtained from students within each classroom cannot be considered statistically independent. That is, because students share common learning experiences provided by the teacher, their scores are likely to be correlated. This correlation among scores violates one of the major assumptions of most widely used statistical methods, such as traditional multiple regression. Second, HLM allows for separation of total variability in the outcomes into variation due to differences in individual students and variation due to differences in teachers (Bryk & Raudenbush, 1992). The HLM analysis will incorporate data from classes prior to SITTE training in order to account for any possible bias due to non-random assignment of teachers to the experimental group.

2. Students in summer classes taught by SITTE teachers will successfully pass algebra classes at a higher rate than other students in comparable classes..

To examine the impact of SITTE program on passing rates in algebra classes, we will use two-level ordinal logistic hierarchical linear models (ordinal logistic HLM) to compare passing rates between students enrolled in SITTE teachers and comparison group teachers.

3. SITTE teachers will demonstrate behavior consistent with the principles of teaching for understanding (TFU), rather than teach for procedural fluency alone.
4. SITTE teachers will demonstrate a deeper understanding about their own instructional decisions and the mathematical thinking of their students.

Quantifiable data from the teacher surveys, observations, interviews, and teacher artifacts, representing before (pre-SITTE) and later stages of implementation (post-SITTE), will be compared statistically both across time and between SITTE and comparison groups. Instruments will be modified forms of Knowledge for Algebra Teaching ((Burrill, Ferrini-Mundy, Senk, & Chazan., 2004) and the RAND *Mosaic II Mathematics Survey* (Stecher et al., 2006). Classroom observation, teacher interview, and classroom artifacts will be used to provide a description characterizing the classroom environment typified in the quantitative data.

5. The teachers who participate in the SITTE training and iSITTE online community will continue effective teaching practices after the summer trainings are completed.

We will use data collected in the years following SITTE trainings demonstrate the extent to which the SITTE training with iSITTE support leads to lasting changes in teacher practice. We will conduct observations and interviews that will allow us to compare pre- and post-SITTE patterns in teacher behavior. These observations and interviews will give us insight into how teachers' beliefs and practices evolve over the course of time.

6. Teacher practices and student scores will correlate with the extent to which SITTE teachers engage in the summer trainings and website activities.

Teacher engagement will be rated qualitatively from teacher logs during training and in the post-training year. We will examine whether the level of engagement is correlated with teacher practice (measured by survey, observation, interview) and student outcome (district and state assessments). The size of the sample (N=120 teachers in 30 teams) will have sufficient statistical power to establish any reasonable sized effects produced by the SITTE training (See Appendix B for details on the statistical power of the proposed measures).

PERSONNEL

The project team includes senior researchers with decades of experience training teachers conducting educational research.

The Project Director, Prof. **Ivan Cheng**, developed the SITTE model as part of his dissertation research under the supervision of Prof. Megan Franke at UCLA. Dr. Cheng will be in charge of training facilitators and will also lead some of the SITTE trainings for teachers.

In additional to teaching in the Department of Secondary Education at California State University Northridge, Dr. Cheng currently serves as the Principal Investigator for a grant sponsored by the Alliance for Regional Collaboration to Heighten Educational Success (ARCHES) and California Engaging Latino Communities for Education (ENLACE), which are part of a joint initiative of the California Academic Partnership Program (CAPP), the California Education Round Table, the California Department of Education, and the University of California.

Dr. Cheng is also working as a lead facilitator with the Institute for Learning at the University of Pittsburgh, in a grant funded by the Irvine Foundation. He possesses over twenty years of classroom teaching experience in both the senior high and junior high levels, and has been an instructional coach for Los Angeles Unified School District. He is a National Board certified teacher in Adolescent/Young Adulthood Mathematics and has presented at workshops and conferences.

Prof. **Brian Foley**, the Co-Principal Investigator, will oversee the data collection and analysis and lead the development of the iSITTE website. Dr. Foley is experienced at creating and studying online learning communities for both students and teachers. His recent research explores how online collaboration tools can support teacher learning (Foley & Chang, 2006). Previous work looked at how online classroom videos can be used to help preservice teachers connect theory to practice (Foley, Livne, & Beck, 2004). His research on the Whyville learning community assess how the features of the website were effective at encouraging girls to participate in science activities online (Foley, Jones, McPhee-Baker & Auschbacher, 2002; Foley & Kobaissi, 2006).

As the current Chair of AERA SIG for Advanced Technology for Learning, Dr. Foley is well connected to researchers working with teachers and technology. Dr. Foley has experience implementing and assessing a large-scale teacher professional development project on the use of Science Notebooks in elementary school with the Caltech Precollege Science Initiative (Roth, Aschbacher & Thompson, 2002). He holds a Ph.D. in Science and Mathematics Education from UC Berkeley where he worked on the Web-Integrated Science Education (WISE) project and taught middle school science.

Prof. **Julie Gainsburg** will be coordinating the collection of observation and survey data from the SITTE and control teachers. An Assistant Professor in the Department of Secondary Education at CSUN, Dr. Gainsburg teaches credential and masters-level math-education courses for pre-service and veteran math teachers and supervises student teachers. As part of the Teachers for a New Era initiative at CSUN, she leads an observational study of recent CSUN graduates to investigate the impact of CSUN's credential program on practicing math teachers. Dr. Gainsburg has produced videotapes of math teachers and incorporated this video into professional development and teacher education. After teaching high school mathematics for ten years, Dr. Gainsburg worked on statewide (Rhode Island) school-reform effort at the Annenberg Institute for School Reform at Brown University, and then joined the Big Picture Company to help design the first of several innovative "Big Picture" schools. She earned her Ph.D. in Curriculum and Teacher Education from Stanford University.

Christy Kim Boscardin of UCLA's Center for the Study of Evaluation (CSE) and Research on Evaluation Standards and Center for the Student Testing (CRESST) will provide guidance on the analysis of student and teacher data and develop the hierarchical linear models of the data. Dr. Boscardin is currently a senior researcher and project director at CSE/CREEST. She received her Ph.D. in Advanced Quantitative Methods from UCLA and has published numerous articles in assessment and evaluation methods.

Several CSUN students will be assisting with this project under the guidance of the PIs and Senior Researcher. Two masters students from the MA program for Mathematics Education will assist in data collection and coding. These students have years of experience in the classroom and training in qualitative research methodology. Three undergraduate computer science majors will assist in developing and maintaining the iSITTE website. While much of the functionality of the site is already in place, several new features remain to be added such as the sketching and graphing tool and equation generation. Beyond this we expect to further develop the site based on the feedback from users and the log file data. We will add features that are needed to help support the use of iSITTE from the project teachers as well as non-SITTE users.

As described earlier, a key role in the SITTE project will be played by district mathematics coaches. The instructional coaches are experienced classroom teachers who have been selected for their content expertise and positive working relationships with their colleagues. They will serve as facilitators during SITTE and lead ongoing support throughout the school year.

RESOURCES

California State University Northridge is a nationally recognized institution in its preparation of teachers. It is currently engaged in the Teachers for a New Era (TNE) project, sponsored by the Carnegie Corporation of New York to re-envision and reform teacher education for today's complex urban classrooms (Carnegie Corporation, 2002). The TNE initiative has allowed the university to bring arts and sciences faculty together with teacher education faculty in conducting research and designing a coherent teacher preparation program based on sound evidence, including the data on student achievement. This collaborative effort suggests that CSUN is well equipped to provide the personnel and knowledge needed to help develop and implement innovative professional development opportunities that can impact student achievement.

The Michael D. Eisner College of Education at CSUN is also involved in research through the Center for Teaching and Learning with funding from the Eisner Foundation and is one of the largest teacher preparation programs in the state of California. In addition to teacher preparation, CSUN offers several master's degrees in secondary education. The MA program for Secondary Mathematics Education is particularly relevant to this study because the students will serve as research assistants as well as participants on the website. The MA program provides training in relevant math education literature, education research and learning theory. Graduating about a dozen students per year, the MA program will provide a pool of potential research assistants who have years of experience teaching mathematics and knowledge of educational research methods. Another master's program is the MA program for Educational Technology. This program is directed by co-PI Foley and some of these students are involved with the development the iSITTE website as part of their own research.

One of the key advantages of CSUN is the close relationship with local teachers, specifically those in LAUSD. The district has been on the cutting edge of teacher professional development and has access to resources with its other partners, including the Institute for Learning at the University of Pittsburgh. CSUN and LAUSD have had a long history of successful collaboration and have resources that can support the implementation of SITTE. The district has trained coaches who can provide support for teachers and has the infrastructure to provide professional development for teachers.

Further, CSUN enjoys the support of Project GRAD, and its local affiliate, Project GRAD Los Angeles. Project GRAD is a national non-profit organization dedicated to helping students graduate high school and attend college. The expertise and resources of Project GRAD can support the work of SITTE and help provide a consistent message to the students and teachers.

Through the connections of the partners—TNE, CSUN, LAUSD, Project GRAD—we expect to be able to impact students beyond the immediate service area of Districts 1 and 2. Our goal is to produce quality documentation of our work so that others may benefit from our research. Dissemination of our findings will occur at national conferences as well as through publications. Further, the ongoing work of SITTE, as it diffuses through the district, will bring theory to practice among the teachers of LAUSD. As a result, we expect the impact of SITTE to be felt beyond the classrooms of the teachers who participate in SITTE.

APPENDIX A

Appendix A includes letters of support from Los Angles Unified School District, Local District 1, Local District 2, Alliance for Regional Collaboration to Heighten Success, and Project GRAD.

APPENDIX B

Appendix B includes a framework for analyzing teaching practices (referenced on p. 7), screen shots of iSITTE (referenced on p. 10), a teaching style survey (referenced on p. 16), an observation instrument (referenced on p. 18), and the power analysis (referenced on p. 20).

APPENDIX A

Los Angeles Unified School District

Instructional Support Services Division

Secondary Mathematics Program

Robert Collins
Chief Instructional Officer

Dr. Liza Scruggs
Assistant Superintendent

Cheri Guenther
Director

Administrative Offices: 333 S. Beaudry Avenue, 25th Floor, Los Angeles, CA 90017
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July 26, 2006

To Whom It May Concern:

For the past five years, Los Angeles Unified School District has been implementing a comprehensive professional development plan to improve student achievement in mathematics by building capacity in teachers. As a result, standardized test scores have risen steadily for more and more students. However, one group that has struggled to show progress is secondary school algebra students. Improving success in algebra, therefore, is one of the district's top priorities.

To support teachers for algebra success, the district has begun several key initiatives, including the use of standards-based instructional guidance systems and periodic assessments aligned with this guidance system. In addition, the district has been providing professional development and school-level support from instructional coaches. One other project of particular interest is the Student Improvement Through Teacher Empowerment (SITTE) program developed by Dr. Ivan Cheng, a former district teacher and math coach.

The SITTE program utilizes summer school as the setting in which teachers can learn new ways to reach their students and apply their learning immediately. It is a job-embedded professional development experience that is truly authentic. Dr. Cheng's preliminary results suggest that SITTE can substantially improve student achievement and promote lasting changes in teacher practices.

It is the district's desire to refine and expand the SITTE program. The SITTE model is aligned with the district's goals and strategies and can serve to enhance other district efforts to improve teacher practice. In addition, the SITTE activity can help support the continued growth of teachers who have participated in other professional development activities organized by the district.

Therefore, the LAUSD central office of secondary mathematics programs is pleased to provide its support for developing the SITTE with Dr. Cheng at California State University Northridge. This support is demonstrated by our commitment to implement programmatic changes in the delivery of professional development using the SITTE model as well as in our allocation of resources and personnel to support the work of SITTE. Funding from the IES grant would provide us an opportunity to evaluate and replicate this model of professional development that promises to be truly effective in raising student achievement and improving teacher practice.

Sincerely,

Cheri Guenther

APPENDIX A

LOS ANGELES UNIFIED SCHOOL DISTRICT
LOCAL DISTRICT 1
6621 Balboa Boulevard, Van Nuys, CA 91406
Telephone (818) 654-3600 Fax (818) 881-6728

ROY ROMER
Superintendent of Schools

JEAN BROWN
Superintendent, District 1

July 13, 2006

To Whom It May Concern:

Like most districts in the nation, the Los Angeles Unified School District faces the challenge of making algebra accessible for all students. In Local District 1, where we have over 120,000 students, algebra continues to be a stumbling block for many, jeopardizing high school graduation, post secondary education, and future employment. Unlike previous generations, today's youth must complete a solid academic foundation, not only for graduation, but for success in today's economy.

Our local California State University at Northridge has long been an important partner in preparing future teachers who are ready to meet the challenges in our classrooms. Academic rigor is more important than ever before, making scaffolding student learning a key issue. Our teachers must be highly skilled to meet today's challenges. Thus, it is with great enthusiasm that we look forward to participating in the *Student Improvement Through Teacher Empowerment* (SITTE) summer professional development program.

We are very supportive of CSUN's plans to expand the scope and work of the SITTE program to provide ongoing support for teachers through an interactive website to allow teachers to remain in collaborate with their colleagues from other schools.

Through research we have learned the critical importance of focusing on practice to improve skills. To that end, the district has added a system instructional coaches who, themselves, study and collaborate in addition to coaching classroom teachers. Thus, we are organized in a way to only partner with CSUN, but to bring our experience and knowledge to the table for our mutual benefit.

We understand that CSUN is applying for grant money from IES to expand the SITTE project to serve greater number of teachers and students. We wholeheartedly endorse this project and look forward to an enriched partnership that will impact student achievement.

Sincerely,

Jean Brown

Jean Brown

APPENDIX A

Los Angeles Unified School District
District 2 - School Service Center

Serving North and East Valley School Communities
5200 Lankershim Blvd., North Hollywood, CA 91601
Telephone: 818.755.5300 Fax: 818.755.2810
Website: http://www.lausd.net/District_2

ROY ROMER
General Superintendent

JAMES MORRIS, Ed.D.
Superintendent
District 2

July 19. 2006

To Whom It May Concern:

Local District 2 of the Los Angeles Unified School District (LAUSD) serves over 106,000 students in the eastern portion of the San Fernando Valley. Minority students make up 88% of the Local District 2's student population and nearly half are classified as English language learners. These statistics underlie the challenges that District 2 teachers face in providing rigorous standards-based instruction for all students. In particular, our data indicate that success in high school mathematics has been a challenge and an area of high concern for the District 2 and, in general, for all of LAUSD.

The high failure rate in secondary mathematics is one of the key barriers to the academic success of students in District 2 as well as one important factor affecting the college going rates of our students. The Institute for Education Sciences Grant for Teacher Quality in Mathematics and Science Education represents a perfect opportunity for District 2 to partner with California State University Northridge (CSUN) in developing strategies to improve the achievement of students the mathematics, while increasing the skills of our teachers to engage in standards-based instruction for all their students.

To that end, District 2 has been exploring an innovative project that uses summer intervention classes for struggling students as a setting for teacher professional development. Since 2004, the district has been working with the university in designing and implementing the Student Improvement Through Teacher Empowerment (SITTE) project. Preliminary results suggest that SITTE can substantially improve student achievement and promote lasting changes in teacher practices.

It is the district's goal to expand the SITTE program to additional buildings beyond the two pilot schools. There is an urgent need to assist teachers in reducing the high failure rate in mathematics, particularly in algebra. The district already has a cadre of instructional coaches who can help implement and sustain effective professional development for the district's secondary mathematics teachers. The SITTE model for professional development would serve as an ideal vehicle for driving the improvement efforts in instructional practice.

Therefore, Local District 2 is pleased to offer its highest support for continuing the partnership with CSUN in developing and expanding the SITTE project to serve the students and teachers of the district. This support is demonstrated by our commitment to implement programmatic changes in the delivery of professional development using the SITTE model as well as in our allocation of resources and personnel to support the work of SITTE. We hope that this funding from the IES grant would provide us an opportunity to evaluate and replicate a model of professional development that promises to be truly effective in raising student achievement and improving teacher practice.

Sincerely,

James Morris

James Morris

ARCHES

560 J Street, Suite 290
Sacramento, CA 95814
Phone: 916 324-8593
Fax: 916 327-9172
Web: www.arches-cal.org

Executive Directors
Dennis Galligani
Diane Siri

July 24, 2006

Dr. Harold Himmelfarb
Institute of Education Sciences
555 New Jersey Avenue, NW
Washington, D.C. 20208

To Whom It May Concern:

On behalf of the Alliance for Regional Collaboration to Heighten Educational Success (ARCHES), I am pleased to support the proposal for an Improving Teacher Quality grant from California State University, Northridge with Professors Brian Foley and Ivan Cheng as Principal Investigators.

ARCHES is an initiative of the California Education Round Table -- an association comprised of the State Superintendent of Public Instruction, the chief executive officers of the public and independent higher educational sectors in California, and the state's planning and coordinating agency for education. The goal of ARCHES is to improve student achievement and close the gaps in educational attainment among groups of students through the development of regional collaboratives throughout California that are composed of school districts, community colleges, baccalaureate-granting institutions, the private sector, and community-based organizations.

The Student Improvement Through Teacher Empowerment (SITTE) project has received financial support and technical assistance through ARCHES since the beginning of 2006 when it was selected as one of our grantees through a highly competitive process. Since that time, we have become familiar with the process used, and the results attained, by the SITTE effort with the Los Angeles Unified School District -- the largest and most diverse district in our state. Additionally, ARCHES has been impressed with the commitment and expertise that the Principal Investigators of this proposal have demonstrated in the activities that they have designed for teachers and in the impact of these activities on student achievement -- the bottom line for ARCHES.

ARCHES expects to continue its financial support for SITTE in the future, although our funding allows us to only provide minimal resources to our grantees. Therefore, the opportunity for SITTE to receive an Improving Teacher Quality Grant would heighten its potential to continue providing teachers and students with the support that they need in order to improve achievement in mathematics -- the gate-keeper or gate-opener discipline to higher education depending upon the skill, competence, and content knowledge of teachers.

ARCHES is pleased to offer its unequivocal support for this proposal from California State University, Northridge. If we can be of further assistance in this process, please contact us at galligani@arches-cal.org or siri@arches-cal.org.

Sincerely,

Dennis Galligani
Executive Director

Diane Siri
Executive Director

APPENDIX A

Project GRAD
LOS ANGELES

July 27, 2006

To Whom It May Concern:

Project GRAD (Graduation Really Achieves Dreams) Los Angeles (PGLA) is a non-profit organization dedicated to helping 20,000 students in the Northeast San Fernando Valley attend and succeed in college. Over the past seven years, PGLA has partnered with K 16 teachers, administrators, parents, students, community leaders, and businesses to increase the number of students entering and succeeding in college, particularly those in the economically disadvantaged area of the northeast San Fernando Valley.

Project GRAD Los Angeles and CSUN have been partners in a number of initiatives and over the last 6 years have developed a positive and successful working relationship. For example, Project GRAD and CSUN are currently working together in providing professional development and intervention for algebra students in the partner LAUSD schools to close the achievement gap among Latino students in the San Fernando Valley. PGLA is pleased to support the efforts of CSUN in the SITTE project. We are especially interested in participating in this new collaborative with California State University Northridge and Los Angeles Unified School District, to examine innovative ways of providing organizational capacity to improve teacher professional development and student achievement.

Project GRAD will provide teacher training as well as learning opportunities for students through after school tutoring, College Institutes, and field trips. Further, Project GRAD will provide personnel and instructional resources to support its work in the SITTE collaborative.

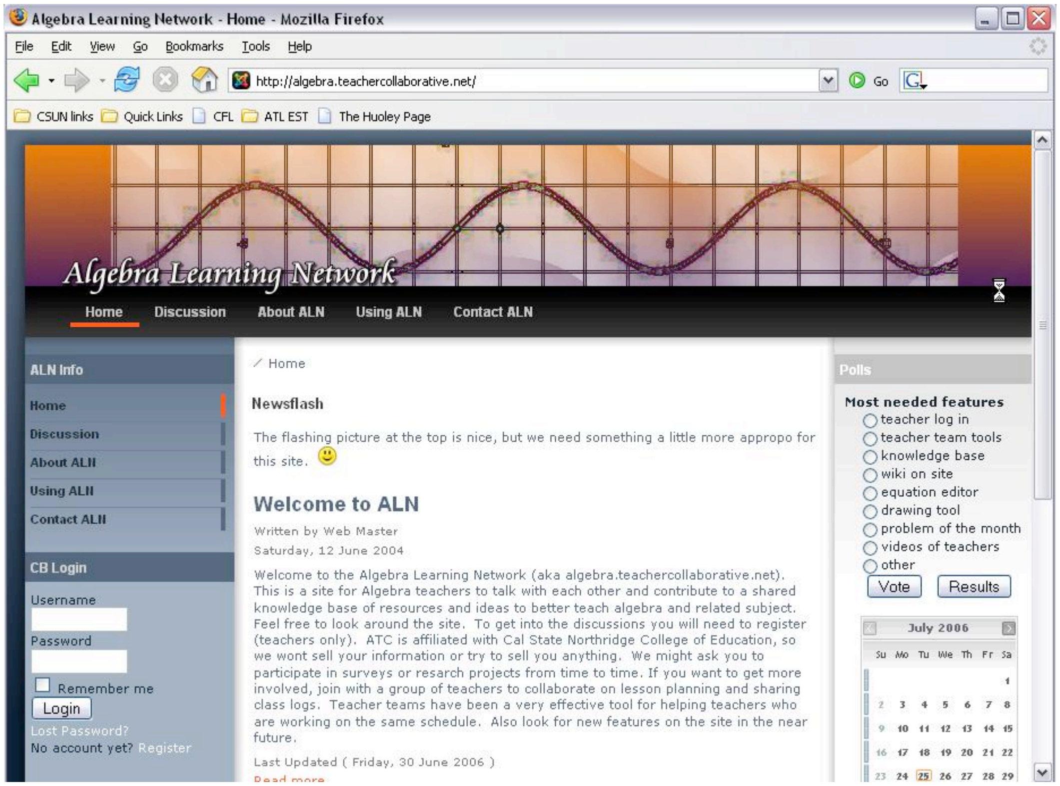
Together with our partners, we look forward to developing innovative strategies that will improve the educational achievement and college going rates of all students, especially Latino students in the San Fernando Valley.

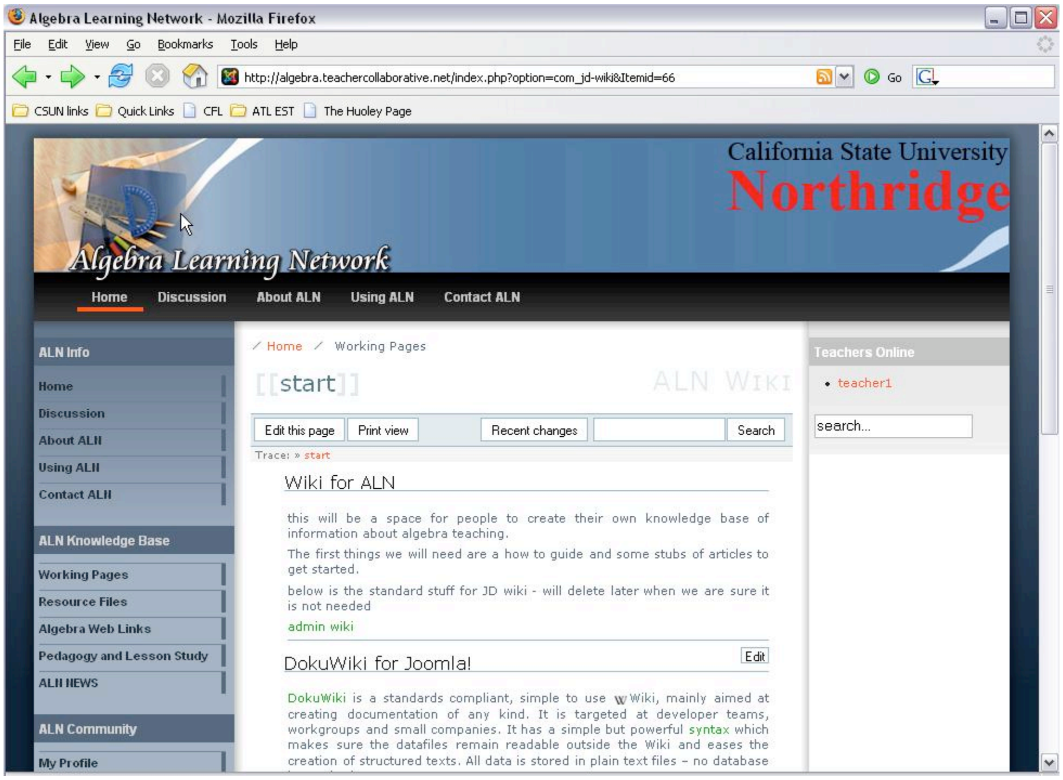
Sincerely,

President & CEO
Project GRAD Los Angeles

APPENDIX B

Screen Shots of iSITTE Website





APPENDIX B

SITTE Teaching Styles Survey

Sample questions based on the RAND Corp. *Mosaic II Mathematics Survey* for grade 9 (Stecher et al., 2006) online at http://www.rand.org/education/projects/mosaic2

A. How does your emphasis on each of the following student mathematics activities in your class compare to that of your primary textbook or published curriculum?
(Circle One Response in Each Row)

	Less emphasis than text	**Same emphasis as text**	**More emphasis than text**
a. Practicing problems designed to improve speed and accuracy	**1**	**2**	**3**
b. Solving complex, multi-step problems	**1**	**2**	**3**
c. Solving real-life problems	**1**	**2**	**3**
d. Engaging in hands-on activities (e.g., working with manipulatives)	**1**	**2**	**3**
e. Explaining answers, justifying solutions	**1**	**2**	**3**
f. Discussing multiple solutions	**1**	**2**	**3**
g. Solving open-ended problems	**1**	**2**	**3**
h. Exploring advanced topics	**1**	**2**	**3**

B. Many teachers divide students into skill-based groups for mathematics instruction and use different teaching approaches for the groups. Approximately what percent of the **total time** you teach **algebra** do you teach differently to skill-based groups?

(Circle One)

0 - 24 % 1

25% - 49 % 2

50% - 74 % 3

75% - 100 % 4

Teaching Scenarios

Instructions. The following questions contain brief "scenarios" or stories that describe teaching situations and ask how you would respond in each case. We know there are many ways to teach mathematics, and you may not organize your lessons in the manner that is presented. Please answer **as if you were in the situation that is described**. The scenarios are brief and do not describe every detail. Assume that other features are similar to your current school and your current students. Please do the following:

a. Read the scenario.
b. Read the first possible option.
c. Circle the response that shows how likely you would be to do this option.
d. Read the next option and circle your response.
e. Repeat the process until you have responded to all the options.

APPENDIX B

SITTE Project Classroom Observation Form

Observer:
Date:

Teacher:	**Algebra Unit:**
School:	**Topic this lesson:**
Type of Class:	**Time** Start: Finish:

See rubric for explanation of ratings.

	1-5	Comment (Evidence for rating)
Classroom management is appropriate with minimum time spent on mgmt issues.		
S-generated exploration and questioning encouraged.		
Meaning making encouraged, and anomalous explanations valued.		
Students **engaged intellectually**, thinking more than superficially about math content.		
Mathematical thinking, thinking about methods, metacognition encouraged.		
Feedback is specific, contains suggestion for further work or improvement.		
Adequate time and structure were provided for **wrap-up** and sense-making.		
Teacher emphasized **higher order questioning**.		
Math **content information** was accurate for this lesson.		
There was a **climate of respect** for students' ideas, questions, and contributions.		

Lesson Summary:

Dimension	Yes	No	Comments/Description (i.e.; how implemented, subject matter, requirements, student reaction, engagement)
Intro/Focus Question			
Recording observations/data collection			
Data analysis/Claims and Evidence			
Class discussion/meaning making			
Written assignment			
Assessment			

<u>Lesson Segments:</u> <u>Copy and complete one table for each class segment. Delete descriptors that do not apply to the segment.</u>

Segment Title and minutes	Config-uration	Teacher Role	Student Role
Into Activity Wrap-up Other	whole class individual small groups (size) other	Giving instructions describing topic &/or goals of lesson giving step-by-step directions clarifying, repeating instructions lecturing/explaining/reading from text questioning lower order; procedural higher order; conceptual used as management eliciting prior knowledge through questioning other demonstrating/modeling with equipment roving among groups linking math with other subjects assessment informal/formative formal, written/summative	listening to teacher responding to questions doing investigation with equipment ST generated prescribed by T writing observations, predictions, questions, drawing, graphing notebook T made worksheet premade worksheet discussing observations, predictions, questions, etc. from an investigation reading text individually aloud w/class writing answers to questions from text

Chronological Field Notes: (note time at 5-minute intervals in left hand margin)

Time	Observable Activity	Comments

SITTE Classroom Observation Rubric (sample only)

	5	3	1
CLASSROOM MANAGEM'T	Excellent classroom management. Students work cooperatively in groups, listening to each other, and respecting each other's contributions Time on important tasks is maximized, not wasted on unnecessary directions, interruptions, etc.	Teacher has to remind students often about what to do and how to cooperate but the class remains fairly orderly; learning activities are not threatened although there may be some time off task due to various confusions or disruptions. Occasional disrespectful comments or behavior but not a lot.	There is very little order in the class. The teacher may have to nag students frequently, typically with little effect. Learning activities are seriously compromised. Very little respect by teacher or students for each other (e.g. lots of negative comments and behavior). Teacher may exhibit negative behavior him/herself or be ineffective with student behavior. May be much time off task.
STUDENT GENERATED EXPLORATION	During at least part of the lesson Ss generate their own ideas and/or questions and investigate or explore them. Either the generation or the investigation may occur as long as the other has occurred or will occur	Ss are asked to give their own ideas and/or questions, but don't get to do anything about them. Must follow prescribed steps. Teacher may comment e.g. "that's an interesting question" but makes no clear steps towards student exploration	Prescribed steps only; Ss do not have opportunity to generate own questions or explore on their own
INTELLECTU-AL ENGAGEMENT	Ss are <u>intellectually</u> engaged throughout lesson	Ss are busy, but partial or sporadic <u>intellectual</u> involvement in activities (may be having fun, but are not thinking deeply about what they are doing)	Ss are not intellectually engaged.
MEANING MAKING OPPORTUNITIES	Teacher provides **strategic questions** and feedback to push students' understanding. Teacher helps Ss focus on and come to understand math concepts and/or the connections among them Ss predict, hypothesize, observe, infer about what they are doing as a means to develop their own ideas and explanations about natural phenomena, e.g. to predict based on what they already know, not just guess; to generalize from what they found, citing evidence and using logical argument, not just recite results. Teacher encourage Ss to discuss	Teacher probes about a principle or concept. This may involve one or several students and one or several sub-questions but is focused on one idea and doesn't last more than a few minutes Ss tell what they did or observed, but little or no discussion or discussion is not substantive; little opportunity to revise their understanding based on what they did Ss may be asked to make predictions, etc, but they are only sometimes asked to	Teacher's questions focuses on knowledge of superficial facts or "are you with me?" questions – no principle-centered questions No opportunity to tell or discuss or make meaning. There is no connection between activities and improving students' understanding of the natural world. May be activity for its own sake. May even be arts & crafts or singing; no serious math content to be understood. The right answer is valued

	findings w/ others to hone ideas and improve understanding. Thoughtful explanations are valued – not just the right answer. "Wrong answers" are valued in honing of ideas. Anomalous results are viewed as interesting and worthy of discussion	link these to an explanation of what they think it means or to their previous notions or misconceptions. Focus may be more on vocabulary/terms &/or the doing of math activities recipe fashion -- not deep conceptual thinking/understanding	w/ no time for explanations. Anomalous results are ignored.
MEANING MAKING OPPORTUNITIES	Teacher provides **strategic questions** and feedback to push students' understanding. Teacher helps Ss focus on and come to understand math concepts and/or the connections among them Ss predict, hypothesize, observe, infer about what they are doing as a means to develop their own ideas and explanations about natural phenomena, e.g. to predict based on what they already know, not just guess; to generalize from what they found, citing evidence and using logical argument, not just recite results. Teacher encourage Ss to discuss findings w/ others to hone ideas and improve understanding. Thoughtful explanations are valued – not just the right answer. "Wrong answers" are valued in honing of ideas. Anomalous results are viewed as interesting and worthy of discussion	Teacher probes about a principle or concept. This may involve one or several students and one or several sub-questions but is focused on one idea and doesn't last more than a few minutes Ss tell what they did or observed, but little or no discussion or discussion is not substantive; little opportunity to revise their understanding based on what they did Ss may be asked to make predictions, etc, but they are only sometimes asked to link these to an explanation of what they think it means or to their previous notions or misconceptions. Focus may be more on vocabulary/terms &/or the doing of math activities recipe fashion -- not deep conceptual thinking/understanding	Teacher's questions focuses on knowledge of superficial facts or "are you with me?" questions – no principle-centered questions No opportunity to tell or discuss or make meaning. There is no connection between activities and improving students' understanding of the natural world. May be activity for its own sake. May even be arts & crafts or singing; no serious math content to be understood. The right answer is valued w/ no time for explanations. Anomalous results are ignored.
MATHEMATIC THINKING, METHODS, DISPOSITIONS	Teacher frequently draws Ss attention to inquiry process; relates what students are doing to what scientists do and how they think. Teacher helps Ss understand the importance and use of mathimatical approaches to understanding the world, e.g. careful	Occasional or superficial mention of mathimatical methods or inquiry, "variables", etc -- and more as something to be memorized than understood as a disposition central to math. Teacher makes occasional comments to indicate slight	Little or no discussion of mathimatical methods or inquiry process, variables, etc. No mention of comparison of what students are doing to what scientists do or how they think. Teacher does not model

	observation and recording of data, what variables are, need for controls and fair tests, reliability of measurement; logical deduction based on evidence. Teacher models values and dispositions associated with math, such as curiosity, openness, skepticism, enthusiasm, e.g. asks students what would they do to find out answers to their questions rather than simply telling them an answer all the time	or incomplete appreciation of mathimatical dispositions.	mathimatical curiosity, skepticism, openness, etc.
FEEDBACK	Teacher provides good feedback to students to guide learning. Feedback is accurate, detailed enough to help students, and constructive	Teacher provides some good feedback but on a sporadic basis, or provides mediocre feedback	Teacher provides no feedback to students or inappropriate feedback (e.g. that makes fun of student or otherwise impedes learning); may ignore poor thinking by students with no attempt to shape students' understanding

APPENDIX B

Power Analysis

Multilevel research designs are increasingly common in educational and social studies. Often with these designs, where interest is in detecting the effects of treatment on units, such as students, that are clustered, e.g., within classrooms, the treatment itself is at the cluster level. This differs from typical designs where each subject (e.g. students) is randomly assigned to the treatment. The purpose of this report is to provide power calculations for determining the sample size needed for detecting the difference between student performance of teachers participating in SITTE and comparison teachers.

Power Analysis & Procedure. This section presents a brief introduction and procedure for conducting power analysis for a cluster randomized trial. Statistical power, usually denoted by 1-β, is defined as the probability of rejecting the null hypothesis given that the alternative hypothesis is true. β is the probability of a Type II error—retaining the null hypothesis when it is false. Conceptually, high power means a high probability of finding a statistically significant difference between the treatment and control groups if one actual exists. Note here that the outcome of interest is measured at the student level but the treatment is assigned at the teacher level so the number or clusters as well the number of students within clusters will influence the variability of the estimated SITTE effect and, hence, the power to detect an effect. The power of the difference test is a function of the following:

Effect size: One of the most difficult steps in the power analysis is to determine the hypothetical or the expected effect size. The effect size can be considered an amount of difference that you expect to find and would considered practically significant between the control group and the treatment group. For the purposes of this study, we define the treatment group as the students enrolled in the SITTE participant teacher classroom. Since outcomes of interest may have different scales, e.g., one content assessment on a different scale than another, the standardized effect size, δ, is used so that the results are meaningful even to those not readily familiar with the particular data at hand. Standardized effect size is calculated as

$$\delta = \frac{\mu_{GLOBE} - \mu_{Control}}{S},$$

where S is the population standard deviation. For example, if the mean difference between the control group and the treatment group is 1.5 with S=3 then the δ=0.5. According to Cohen (1977), the effect size of 0.5 would be considered a medium effect and effect sizes as small as 0.20 may be considered practically significant. As the criterion for this study, we will recommend a design that has high power for detecting an effect size of at least 0.40 but will also explore modification that would be necessary for reasonable power at a smaller effect size.

Reliability of the outcome measure: It will be assumed for this study that the reliability of the outcome measure is 1. In the case of an assessment tool with less than perfect reliability, it is well known that the estimated effect of treatment on the assessment scores will be attenuated, i.e., the measured effect size will be smaller than the actual effect size. Exploring the design requirements for effect sizes smaller than the projected 0.40 should allow the study to be well-powered, even in the presence of some degree of measurement error.

Power: Statistical power is defined as 1- the probability of Type II error. In other words, if we believe that 20 percent chance of Type II error is tolerable then a power of .80 is necessary for the study. Given the high stakes involved with the data, .80 or higher would be optimal for this study.

Significance level or Type I error level: A Type I error is mistakenly rejecting the null hypothesis when it is, in fact, true. There is a trade-off between the Type I and Type II error rates. By decreasing the α-level for the hypothesis test, the probability of a Type II error, retaining the null hypothesis when it is false, increases. For this study, we will use the conventional choice of $\alpha = 0.05$.

Intra-class correlation (ICC): Usually denoted by ρ, the intra-class correlation is the proportion of the total variability in student outcomes due to cluster membership. Conceptually, ρ is a measure of the extent to which observations (i.e., students) are not independent within each cluster (i.e., classroom). The ICC is calculated as

$$\rho = \frac{\tau^2}{\tau^2 + \sigma^2},$$

where σ^2 is the variance in student outcomes within classrooms, τ^2 is the variance between clusters, and $\tau^2 + \sigma^2$ is the total variance (S^2 from the standardized effect size definition). ρ takes on values between 0 and 1. A value of 1 would mean that all the students in a given classroom have the same score, i.e., no variability within classroom—the essential sample size, in terms of the number of independent observations, would then be only the number of classrooms. A value of 0 would mean that all students in a given classroom are independent observations, i.e., no variability in the classroom means—the essential sample size, in terms of the number of independent observations, would then be the total number of students across all classrooms. An ICC in the range of 0.05 to 0.15 is typical for data sets on school achievement (Raudenbush, Liu, & Congdon, 2004) and what we will consider for this study.

Cluster size: Denoted here as n, the cluster size refers to the number of students in each classroom. For this power calculations, we assume n=30.

Number of clusters: Denoted here as J, this refers to the number of classrooms in the study. For this study, we will assume that the number of teachers assigned to SITTE will be equal to the number assigned to the control condition.

The purpose is to inform the study design with respect to the necessary number of teachers to achieve a sufficiently powered study to detect SITTE effect on student outcome.

<u>Results</u>. The analysis for this power study was conducted using the Optimal Design program, Version 0.23, developed by Liu, Congdon, and Raundenbush (2001). The program assumes that the data are balanced, i.e., there are an equal number of students in each classroom. In this case, we have specified n = 30. The program determines the power level based on the distribution of the *F* statistic from an ANOVA, comparing the treatment group variance to the cluster variance. Under the null hypothesis of no difference between treatment and control groups, the *F* statistic follows a central *F* distribution with 1 and J-2 degrees of freedom while the *F* statistic under the alternative hypothesis of a non-zero effect size follows a non-central *F* distribution.

Figures 1 display the plots produced by Optimal Design for effect sizes of $\delta = 0.20$. The plot shows statistical power for the difference test as a function of the number of clusters stratified by the intra-class correlation, ρ, at values 0.05, 0.10, and 0.15. All plots assume $\alpha = 0.05$. Tables 1 display the minimum number of total teachers needed for effect sizes of $\delta = 0.20$ respectively for power levels 0.70, 0.80, and 0.90 and $\rho = 0.05$, 0.10, and 0.15. For example, if you assume small effect size (0.20) and low (e.g. 0.15) ICC for the study, the recommended sample size is > 100 with power of 0.90 (see Table 1). Based on the research design, the study is planning to provide SITTE training to 120 teachers over the four years

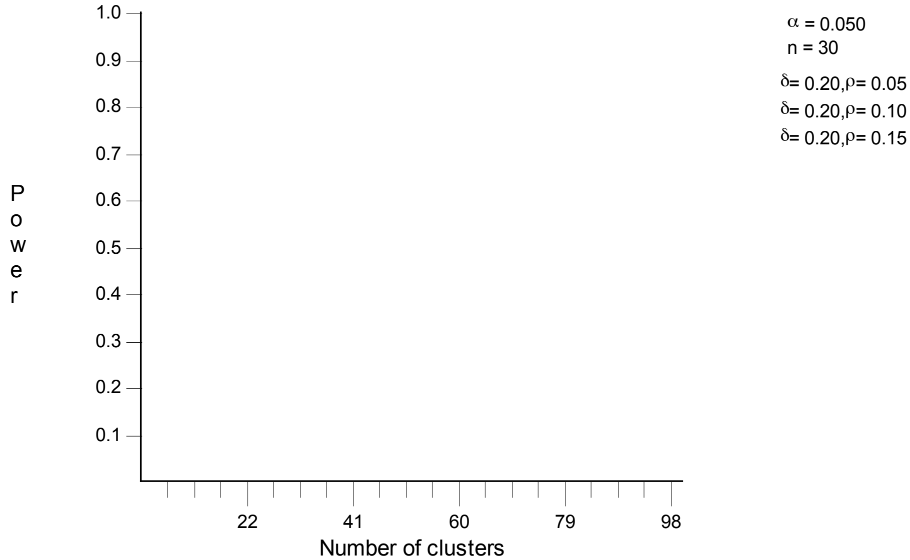


Figure 1. Power vs. Number of clusters for $\delta = 0.20$, $\rho = 0.05, 0.10, 0.15$

Table 1. Number of clusters (classrooms) for $\delta = 0.20$; $\beta = 0.30, .20, 0.10$; $\rho = 0.05, 0.10, 0.15$

	Power = 1-β		
ρ	0.70	0.80	0.90
0.05	**52**	**66**	**87**
0.10	**83**	**> 100**	**> 100**
0.15	**> 100**	**> 100**	**>100**

Note: $\delta = 0.20$ is considered small effect size.