STUDY OVERVIEW

Purpose: This full research and development proposal responds **to DR-K12's Challenge 2,** "**How can all students be assured the opportunity to learn significant STEM content?**" It focuses on a new type of school that is quietly emerging across the US, *Inclusive STEM-focused High Schools (ISHSs*). Unlike older, highly selective STEM-focused schools that target students already identified as being STEM gifted/talented, the goal of ISHSs is to develop new sources of STEM talent among underrepresented minority students, and provide them with the means to succeed in school and in STEM jobs, college majors, and careers (Means, Confrey, House, & Bhanot, 2008; Scott, 2009). ISHSs have the exciting potential to create entirely new opportunity structures (Roberts, 1968) for students underrepresented in STEM fields because they help connect the dots between K-12 schooling, higher education, and STEM jobs and careers through innovative education programs that are delivered at the school level, but expand the boundaries of the normal school day and year (Carnegie Corporation, 2009). ISHSs blur boundaries between formal and informal education, and can potentially reconfigure relationships among teachers, students, and knowledge (Coburn; 2003; Elmore, 1996). Their innovative school designs are pushing limits for practice by engaging students with their communities, STEM business and industry, and early opportunities for higher education experiences (Means et al., 2008).

Need for Cohesive Research: However, ISHSs are a new phenomenon and their ability to meet their goals (raising the STEM achievement of underrepresented students and creating new learners ready for college STEM majors and careers) has not been well-documented in the research literature, although reports of ISHSs can be found in the popular media. Moreover, several states have incorporated ISHSs into their overall state STEM plans. However, there appears to be no published rigorous*, on-site* comparative studies of ISHSs designed to make systematic comparisons across ISHSs; between ISHSs and their comprehensive school counterparts; or, that used a set of common measures guided by cohesive research design. **This proposed study, *Multiple Instrumental Case Studies of Inclusive STEM-focused High Schools: Opportunity Structures for Preparation and Inspiration(OSPrI)* and referred to as *OSPrI* in this proposal from this point on, aims to fill this research gap**. *OSPrI* will develop a body of evidence to identify the critical components of ISHSs and propose a common theory of action. (See letters of support.) This is crucial to understanding implementation and the potential for the successful scale-up of ISHSs (Chatterji, 2002; Desimone, 2002; Lynch, in press a; Lynch et al., 2007; McDonald et al., 2006).

Overview of Design: The *OSPrI* research team has identified 10 candidate critical components that guide STEM-focused high schools. Phase 1 of the study will focus on 12 well-established "exemplar" ISHSs, i.e., schools that have been carefully planned as inclusive STEM-focused schools, with community and business support, and that have good reputations, although they may be quite new. We will study their designs and implementations in their varied contexts, assaying student STEM outcomes for each ISHS compared with school district and state means. Phase 1 will create a theory of action for ISHSs, and result in 12 rich case studies of ISHS models, cross-case analysis of the 12, and a set of instruments and rubrics for gauging STEM design and implementation. In Phase 2 we will select 4 promising ISHS models for further study, focusing on student-level experiences and drilling more deeply into district-level databases for comparisons of student outcomes with comprehensive schools in the same district. Such comparisons are sorely needed to define what constitutes an ISHS and to gauge the benefits of ISHSs against a "reasonable comparison" to comprehensive high school counterparts. Phase 2 will develop parameters of a fair test of school types. Unlike coverage of alternative schools by the popular media (e.g., *Waiting for Superman, The Lottery)* that suggests that *any* alternative is superior to the comprehensive school counterpart, the set of 4 matched school cases should assist educators and policymakers in making decisions about ISHSs and their potential to increase the pool of STEM-prepared and inspired students.

BACKGROUND AND NEED FOR STUDY

Policy and Research Base:

Policy Initiatives. In September, 2010, President Obama issued a challenge to the U.S. educational system to create more than 1000 new STEM-focused schools over the next decade, including 200 high schools (Obama, 2010). This was stimulated by a report from the President's Council of Advisors on Science and Technology (PCAST): *Prepare and Inspire: K-12 Education in STEM for America's Future* (PCAST, 2010). The report points out that the success of the U.S. in the 21st century, its wealth and welfare, depends on the ideas and skills of its population. As the world becomes increasingly technological, the value of these assets will be determined by the quality of its STEM education. In order to meet immense challenges in energy, health, the environment and national security, we need a greater portion of the populace better prepared in STEM, and generally more STEM literate. This report points out that the U.S. is not only falling behind in STEM proficiency in its K-12 education system, its students are also falling behind in STEM interest. This is particularly troubling for students who are under-represented in STEM fields. African-Americans, Hispanics, Native Americans and women are often shut out of STEM opportunities, but students from low-income families or rural students may also find STEM careers inaccessible. "The United States cannot remain at the forefront of science and technology if the majority of its students—in particular women and minorities underrepresented in STEM fields—view science and technology as uninteresting, too difficult, or closed off to them." (p. 36). These problems have been documented for decades, but not slaked, in policy pieces such as *A Nation at Risk* (NCEE, 1983), *Before It's Too Late* (NCMST, 2000), *Rising Above the Gathering Storm* (NAS, 2005), *Report of the Academic Competiveness Council* (USDOE, 2007), *The Opportunity Equation* (Carnegie Corporation, 2009), and NSF's annual *Indicators Reports*.

The creation of STEM-focused schools was a named a priority made by PCAST and President Obama because of the promise of ISHSs for closing the STEM opportunity to learn and interest gap. These schools have captured the imaginations of policymakers and business/industry as an under-explored potential resource for economic progress as well. The Carnegie Corporation's (2009) *Opportunity Equation* states that there is much to learn about the most effective *school* designs (emphasis ours) for realizing high levels of achievement in science and math by all. New urban schools, charter schools, and specialized schools for STEM, both inclusive and selective, could provide a portfolio of different options from which school districts might select (Carnegie Corporation, 2009; PCAST, 2010). Such schools also provide a variety of models for new student pathways to success. The *Opportunity Equation* argues persuasively that "Math-and-science-themed schools have often been highly selective, but a new generation of schools with STEM themes are accepting students regardless of past academic achievement and preparing them for the challenges of the 21st century workplace. New Tech High School, in Napa, California, and the network of schools based on the New Tech model are examples". Another example is MC2STEM High School at GE's Nela Park, a new public school that was given a building on General Electric's campus and was created largely through corporate funds. MC2STEM was re-tooled and re-imagined for STEM subjects, relying heavily on new learning technologies. It has a state-of-the-art "FabLab" modeled on the concepts of MIT's Center for Bits and Atoms, and promotes activities that range from technological empowerment, to peer-to-peer project-based technical training, local problem solving, small-scale high-tech business incubation, and grass-roots research. Although this school's track record is completely untested, its model has captured the attention of policymakers and business leaders who are eager to be involved (Ott, 2009).

Research on ISHSs. There is little information about how many STEM-focused schools (inclusive or selective) exist in the U.S., and what is there is somewhat contradictory. Subotnik et al. (2010) report that there are about 100 such schools in the U.S. But a SRI study on STEM high schools commissioned by the Gates Foundation located about 315 self-identified STEM secondary schools that met that study's criteria, with 203 schools responding to a survey (Means, et al., 2008). The study found that 80% of STEM secondary schools are public non-charter schools and 15% are charter schools. The responding schools were divided into two general types. One group consisted mostly of older STEM schools with an established mission of providing gifted and talented students with accelerated and advanced STEM coursework. The second group, 55% of the total respondents, was a new type of school that focuses on preparing underrepresented, minority youth for the successful pursuit of advanced STEM studies. They have the promise of providing a critical mass of nontraditional STEM students, defying stereotypes about who does STEM and creating positive STEM identities (Carlone & Johnson, 2007). The ISHSs are young in age and have not been systematically studied, with exception of studies of charter schools that also happen to be STEM schools. Clearly, with over 100 ISHSs already identified, and an unknown number newly established or not captured by the SRI study, this new movement needs to be explored systematically at a level beyond survey study because it can provide exciting new possibilities for students, their communities, and the economy.

Reason for caution and need for research. The proposed research is important because it aims to describe models of ISHSs that have a record of success in their school districts, and to identify critical components in context. There is anecdotal evidence that the rush to create new STEM-focused schools may have pitfalls, unless a clear notion of what constitutes a successful ISHS is developed. For instance, in one urban school district, a number of schools have been converted to "STEM schools" in title, but made no changes to curriculum, instruction, teaching staff, or teacher professional development; the only innovation was the installation of interactive electronic whiteboards. In another large urban school district, STEM schools (in name) actually post lower STEM test scores than the school district average. Principals of well-established ISHSs are understandably concerned that their efforts to establish innovative, potentially transformative new programs may be weakened by schools that have adopted the STEM title and not much else. Moreover, federal Race to the Top state competition winners plan to create more STEM-focused schools, including using the STEM focus as a means to turn around consistently underperforming schools (Robelen, 2010). They need viable, plausible models. These issues make a compelling case for the *OSPrI* research program which will provide cases of models for innovators interested in STEM-focused schools. We will document critical components, develop tools for evaluation, and build a theory of action for effective ISHSs.

Theory, Candidate Critical Components, Organizational and Research Frame:

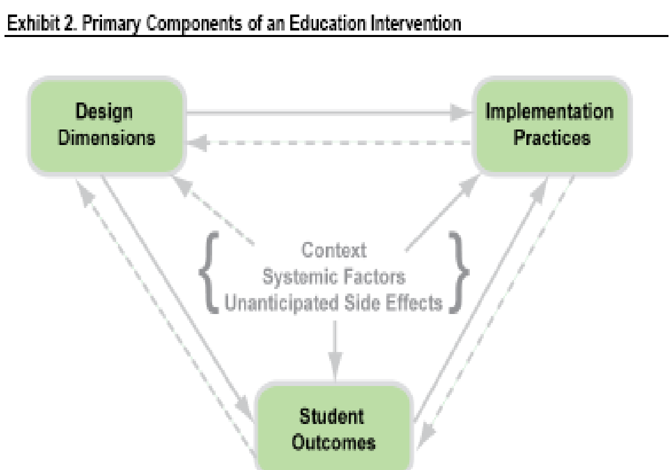
Theoretical Perspective. *OSPrI* hypothesizes that successful ISHSs do more than focus on STEM or use new technologies. Rather they create new *opportunity structures* for their students. This term was first used by Kenneth Roberts (1968) in his work with British youth to describe conditions that could lead a juvenile to criminal activity if pathways to success (such as decent schooling) were blocked. Roberts said that "momentum and direction of school leavers' careers are derived from the way in which their job opportunities become cumulatively structured and young people are placed in varying degrees of social proximity, with different ease of access to different types of employment" (p.179). In other words, psychological choice did not govern success so much as the actual physical and social affordances that are found in some geographic locations, but not others. Determinants of occupational paths include the home; the environment; the school; peer groups; and job opportunities. Roberts (1984) later expanded his opportunity structure model to include factors such as distance to work (or school), job qualifications, informal contacts in business, ethnicity, gender, and cyclical and structural factors operating within the economy that result in a demand for labor with high skill levels (c.f. Wilson, 2009 for a discussion of structural and cultural forces shaping poverty and opportunity in U.S. urban environments). Although "opportunity structure" was used by Roberts to explain how youth chose deviant career paths, it can be adapted to consider what it would take for students underrepresented in STEM—often less affluent, minority students—to move into rewarding STEM fields. ISHSs, either deliberately or intuitively, must create opportunity structures designed to guide and support students for STEM jobs, college majors and careers.

Candidate Critical Components. The literature on ISHSs suggests a set of critical components that may work together to form new opportunity structures for students. However, unlike well-established whole-school reform programs such as the James Comer's School Development Project (Comer, 2009) or Success for All (Success for All Foundation, 2010), ISHSs are not organized under one umbrella philosophy or organizational structure (c.f. Rowen et al., 2009). The PCAST Report (2010) notes that most STEM-focused schools are singular creations and there are few attempts to scale the successful ones. Rather, ISHSs may be viewed as a series of related "education experiments" (Bryk & Gomez, 2008; Carnegie Corporation, 2009; PCAST, 2010). ISHSs may share common goals, but there is no single explicit theory of action (Chatterji, 2002) that undergirds how they function; they are too new on the scene and varied in their designs and origins. However, some groupings of ISHSs have defined models such as the High Tech High (Rosenstock, 2008) or the New Tech High Foundation (2010). By reviewing the existing literature on both inclusive and selective STEM-focused high schools and analyzing websites of ISHSs, we have identified a candidate set of 10 critical components for ISHSs that forms the basis for our inquiry. We have been unable to find research that shows causal claims or correlational relationships between the presence of each component and student outcomes *in ISHSs.* However, a component such as "Well-Prepared STEM Teaching Staff" has a strong research base in STEM education (Brewer & Goldhaber, 2000; Monk, 1994; Monk & King, 1994; Rowan, Chiang, & Miller, 1997). The 10 critical components in Exhibit 1 form working hypotheses, the basis to develop a theory of action for ISHSs.

Exhibit 1: Candidate Critical Components
1. STEM-Focused Curriculum. Strong courses in all 4 STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects (Atkinson et al., 2007; Brody, 2006 as cited in Subotnik, Tai, Rickoff, & Almarode, 2010; Kaser, 2006 as cited in Means et al., 2008; Means et al., 2008; Rosenstock, 2008; Scott, 2009). ***2. Reform Instructional Strategies and Project-Based Learning.*** STEM classes emphasize instructional practices/strategies informed by research found in *Adding It Up* (NRC, 2001), *Taking Science to School*, (NRC, 2007), *Learning Science in Informal Environments* (NRC, 2009), *Restructuring Engineering Education: A Focus on Change* (NSF, 1995), *Fostering Learning in the Networked World* (Borgman et al., 2008) for active teaching and learning (Lynch, 2008) and immersing students in STEM content, processes, habits of mind and skills (Atkinson et al., 2007; Means et al., 2008; Scott, 2009). Opportunities for project-based learning and student production are encouraged, during and beyond the school day. Students are productive and active in STEM learning, as measured by performance-based assessment practices that have an authentic fit with STEM disciplines (Atkinson et al., 2007; Means, 2006; Means et al., 2008; New Tech High, 2010; NRC, 2004, 2005, 2007, 2010; Rosenstock, 2008; Subotnik et al., 2010; Scott, 2009). ***3. Integrated, Innovative Technology Use***. Technology connects students with information systems, models, databases, and STEM research; teachers; mentors; and, social networking resources for STEM ideas during and outside the school day (Means et al., 2008; NRC, 1999, 2009; New Tech High, 2010; Rosenstock, 2008). The school's structure and use of technology has the potential to change relationships between students, teachers and knowledge (Borgman et al., 2008; Coburn, 2003; Elmore, 1996; Rosenstock, 2008) and flatten hierarchies (Atkinson et al., 2007; New Tech High, 2010; Scott, 2009). ***4. Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year:*** Learning opportunities are not bounded, but ubiquitous. Learning spills into areas regarded as "informal STEM education" and includes apprenticeships, mentoring, social networking and doing STEM in locations off of the school site, in the community, museums and STEM centers, and business and industry (NRC, 2009; PCAST, 2010, Rosenstock, 2008). As a result, the relationship between students, teachers and knowledge changes (Coburn, 2003; Elmore, 1996), and hierarchies flatten to "*...substantially alter the traditional roles of learners, teachers, and instructional resources in the learning environment"* (NSF-DR-K12, 2010, p. 7). ***5. Real-World STEM Partnerships***: Students connect to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year (Atkinson et al., 2007; Brody, 2006 in Subotnik et al., 2010; Kaser, 2006 in Means et al., 2008; Kolicant & Pollock in Subotnik et al., 2010; Lee 2002; Means et al., 2008; Rosenstock, 2008; Stone III et al., 2006 in Means et al., 2008). This is envisioned in DR-K12 solicitation: *"The responsibilities for meeting the*

goals of formal education will undoubtedly shift to include a broader community of stakeholders, such as informal institutions, STEM professionals, parents and caregivers" (NSF DR-K12, 2010 p. 7).
6.Early College-Level Coursework: School schedule is flexible and designed to provide opportunities for students to take classes at institutions of higher education or online (Atkinson, et al., 2007; Cavanaugh, 2006; Martinez & Klopott, 2005; Means et al., 2008; Rosenstock, 2008; Subotnik, Rayback & Edminston, 2006 as cited in Means et al., 2008).
7.Well-Prepared STEM Teaching Staff: Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers (Means et al., 2008; Subotnik et al., 2010)
8.Inclusive STEM Mission: The school's stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented groups (Means et al, 2008; PCAST, 2010; Scott, 2009, Obama, 2010).
9. ***Administrative Structure:*** The administrative structure for inclusive STEM education varies (school-within-a-school, charter school, magnet school, etc.) and is likely affected by the school's age (less than a full set of grade cohorts) and the school's provenance, i.e., whether the school was converted from another model or was created "from scratch" as a STEM school (Means et al., 2008; Scott, 2009)
10.Supports for Underrepresented Students: Supports such as bridge programs, tutoring programs, extended school day, extended school year, or looping exist to strengthen student transitions to STEM careers. Such supports result in altered, improved opportunity structures, i.e., students are positioned for STEM college majors, careers, and jobs; and student social structures and identities change to accommodate new opportunity structures (Carnegie Corporation, 2009; Lee, 2002; Means et al., 2008).

Conceptual Framework. The conceptual framework for this study draws upon and extends the evaluation framework proposed in the NRC Committee that reviewed K-12 Mathematics Curricular Evaluations (Confrey & Stohl, 2004) and modifies the survey framework used in the STEM High Schools study (Means et al., 2008). Exhibit 2 suggests that in order to understand an ISHS as an instructional and educational entity, there are 3 primary dimensions to consider: the program's design, the program as implemented, and student outcomes. These dimensions interact (Means et al., 2008), and are moderated by the school's context. The elements in a school's design dimension may include the school's goals, governance, or academic structure, student recruiting and selection, curriculum and pedagogy, and outside partnerships (Means et al., 2008). The *OSPrI* study will especially focus on the 10 critical components in Exhibit 1. The implementation dimension includes the extent to which intended design and critical components are put into practice. For instance, a school may have *design goals* for integrated technology throughout the school program or for student participation in business/industry mentorships outside the normal school day. How consistently and in what ways these goals are actualized in a school's *implementation* would vary from school, and likely affect outcomes, depending on context. Thus, it is important not only to document /describe implementation of critical components, but also to gauge the extent to which the candidate critical components are implemented. Fidelity of implementation of critical components likely moderates important student outcomes (Dane & Schneider, 1998; Dusenbury et al., 2003; Lynch, 2008; Lynch et al., 2007, 2008; Mowbray et al., 2003; O'Donnell, 2008). For the *student outcomes* dimension, there is overall agreement that ISHSs should improve underrepresented students' preparation in STEM in ways



that inspire and provide requisite background knowledge and skills, instilling confidence and desire to seek more STEM education, jobs and careers (Means et al., 2008; NRC, 2004). However, other outcome goals may vary by school, some focusing on student products, engineering skills designed for local contexts, or accumulating college credits. Moreover, because publicly funded schools are subject to state-level accountability, ISHSs likely need to show that their students have improved near-term outcomes (assessment data, earned STEM credits, STEM gatekeeper courses taken, prizes and awards), mid-term outcomes (graduation and drop-out rates, college admissions rates, STEM-intensive jobs), and long-term outcomes (college major, STEM credits, college graduation, and STEM careers). All three dimensions in Exhibit 2 are affected by contextual factors, systemic factors, and unanticipated side effects, including life events, community resources, and environments beyond the typical school day or school building.

RESEARCH DESIGN

The candidate set of critical components listed in Exhibit 1 will be explored for each Dimension in Exhibit 2 and Context. This will occur in the proposed *OSPrI* study in two phases: Phase 1 explores the conceptual framework across 12 ISHSs, while Phase 2 compares 4 ISHSs with their comprehensive school counterparts in the same school districts, including student-level cases.

Phase 1 Questions and Research Design:

- 1. Is there a core set of likely critical components (listed in Exhibit 1) shared by well-established, promising ISHSs? Do other components emerge from the study?
- 2. How are the critical components implemented in each ISHS?
- 3. What are the contextual affordances and constraints that influence each ISHS's design, implementation and student outcomes, within and across ISHSs?
- 4. How do ISHS student STEM outcomes compare with school district and state averages (e.g., STEM achievement measures, graduation rates, college intentions)?

The Multiple Instrumental Case Study Method. This study will employ a multiple instrumental case study design (Yin, 2003), also called a collective case study design (Stake, 1995, 2006). This method is used to describe and compare similar phenomena to provide insight. Research using this method to study school-level redesign include SRI studies of International Baccalaureate programs (Bland & Woodworth, 2009), KIPP schools in San Francisco (David et al., 2006), small high schools and their learning cultures (Shear et al., 2005), and Chicago's Renaissance Charter Schools (Young et al., 2010), as well as CPRE's studies of school districts' strategic management of human capital (Koppich & Showalter, 2008) and Stanford's School Redesign Network led by Linda Darling Hammond (e.g., Wentworth, 2010). This method is ideally suited to the proposed study because it is a systematic and coherent approach to studying new school models such as ISHSs. It provides a means for rigorous cross case analyses, but also is open-ended, allowing new empirical evidence and interpretation to inform the research. Consistent with this approach, *OSPrI* cases of ISHSs will be purposefully selected based on their potential to be representative of well-established ISHSs (criteria are discussed below). The cases will be instrumental because they will both illustrate the characteristics of each ISHS studied and describe common critical components in ISHSs.

Sites, Samples, Recruitment and Incentives. In Phase 1 of the study, 12 inclusive STEM schools will be selected for case study. The selection process will combine an expert nomination process with screening and categorization according to key design dimensions. The schools will be purposefully chosen as critical cases (Yin, 2008), and will have a variety of governing structures and academic organizations likely to have broad effects on implementation and outcomes. Case studies of student-focused charter schools (Shear et al., 2005) suggest that STEM schools created as transformations of existing schools will be quite different from newly established STEM schools. Likewise, establishing a distinct culture and set of norms for a school-within-a-school entails challenges not shared by whole-school designs (Shear et al., 2005). Whether a STEM school focuses on a specific occupation/subject (such as engineering) or intends to provide college preparation in all STEM fields are important distinctions. The selection of schools will reflect differing administrative structures and geographic diversity across the U.S. We expect that the 12 cases will include one or more ISHSs from North Carolina, Ohio, and Texas where there is state-level support for ISHSs and well-constructed databases to gauge student outcomes.

We will begin the nomination process by contacting individuals knowledgeable about STEM schools at the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST); state networks in North Carolina, Ohio, and Texas; the National Governors Association STEM Initiative; the Carnegie Corporation; and the Gates Foundation. We will review our definition of ISHSs with these experts and ask for their nominations of schools that are particularly good examples of the concept. When an expert nominates a school, we will ask for information about the critical components in Exhibit 1 and whether it is a transformation or new school; independent campus or school-within-a-school; and has a broad or narrow academic focus. Nominated schools that participated in the SRI STEM survey will also have this information reported by the school's leader in 2007.

Once the nominations are completed, we will gather publicly available information on school design and implementation, and then select 24 schools for screening calls. We will verify the collected information, fill in any missing data for the 10 critical components, and determine if the school wishes to participate in the *OSPrI* study. Using this information, we will select 12 schools representing different STEM models and providing geographic variation. (See letters of support.)

Next, having secured the commitment of the final 12 ISHSs, we will recruit an on-site study facilitator for each school, based on suggestions from the school principal (who may self-nominate). The on-site facilitator will update the SRI survey information and screening information, elaborating on the 10 critical components and identifying other important aspects of the school's design, model, and goals not captured in Exhibit 1. The on-site facilitator will work with the *OSPrI* research coordinator to plan site visits, including scheduling classroom observations, focus groups, and interviews with teachers, administrative staff, students, and members of community and business/industry/higher education closely involved with the school. On-site visits will provide information on the Implementation and Outcome Dimensions, in Contexts (see Exhibit 2). The on-site facilitator will receive \$3000 stipend in two parts, \$1000 to provide pre-visit information and organize the site visit, and \$2000 when the school case study is completed. In addition, each ISHS will receive \$5000 as an incentive to participate. This incentive may be awarded in a lump sum to the school after its case study is completed, or the school may use the \$5,000 to pay for substitute teachers, teacher and student participation stipends, or provide modest amounts of food (pizzas) for focus-group and after-school meetings.

Data Sources. Data sources have been carefully considered for their ability to provide complete and accurate descriptions to address the research questions, mindful of efficiency and feasibility (King, Keohane & Verba, 1994). They include:

- *School documents and public database information* such as curriculum or pacing guides, scope and sequence documents, and data on school demographics and outcomes;
- *SRI Survey (2008)* data will be updated for each ISHS; this instrument with responses from a school administrator provides a systematic overview of the critical components in Exhibit 1, and will be revisited in telephone interviews for more elaborated information;
- *Observation Protocols.* Validated observation protocols will be used when possible, or existing protocols will be modified to capture critical components (see below for examples).
- *Focus Groups.* Focus groups will be conducted by two researchers, a facilitator and a recorder/note taker. Question prompts for each group will be devised based on critical components. Focus group composition will be organized in two ways: by characteristic (e.g., 10^{th} grade students, math teachers) and thematically by candidate critical component (e.g., use of technology in instruction). Each focus group will have between 6-8 participants, drawn from a pool of volunteers and composed to represent a balance of demographic and other factors.

- *Administrator Interviews.* Administrator interviews will be conducted at three points in the study: before the school visit to obtain preliminary information; during the school visit to obtain more in-depth information; and, after the case study is drafted as a check on the accuracy of case evidence and interpretation. The pre-visit interview will primarily capture Design, while the in-depth interviews will address Implementation and Outcome Dimensions and Context.

Procedure. Because *OSPrI*'s study of ISHSs includes an in-depth examination of the quality of teaching and learning in each STEM discipline, the *OSPrI* research team has been constituted for disciplinary expertise in science, technology, engineering and mathematics education. The *OSPrI* study team consists of one senior staff person for each STEM discipline and one research assistant for each. However, there are aspects of the study that require an interdisciplinary perspective, such as the exploration of early college coursework, or administrative structures that support students in an ISHS. The *OSPrI* team has sufficient depth (e.g., organizational and educational psychology, policy, etc.) to reasonably address all critical components. Each ISHS case study team will be led by one of the senior staff. A 4-person STEM team will travel to the ISHS to gather empirical data, and later analyze it and assist in case writing. For each ISHS selected for study, as much Design Dimension information as possible will be collected via telephone interviews and using existing school documents and website information prior to a school site visit. The school site visit will focus primarily on the Implementation and Outcomes Dimensions and Context (see Exhibit 2). The site visits will be carefully organized to gather maximum information over a 4-day period and to minimize travel costs. A sample schedule is presented below in Exhibit 3. Each activity block in Exhibit 3 will be conducted by two researchers working in tandem. For instance, for a 9th-grade science classroom visit, a science educator would employ a science classroom observation instrument, while an accompanying technology or engineering educator would use an instrument that captures the engineering and technology applications during the science class. Assigning two researchers per activity block should help optimize the reliability of the data collected, improve the quality of the instruments and protocols adapted or developed for this study, and assist with triangulation and interpretation of data.

Exhibit 3. Sample Sit Visit Schedule

Researcher	Science	Technology	Engineering	Math
Day 1: AM	Orientation, School Tour / Interviews with STEM disciplinary leaders			
PM	Classroom visits: 9th grade science and math (2 researchers/class)			
Post	Focus Group: Science teachers		Focus group: 9th grade students	
Day 2: AM	Classroom visits: upper-level science and math (2 researchers/class)			
	Focus Group: 11th grade students		Focus Group: 12th grade students	
PM	Classroom visits: specialized STEM classes focus on engineering and tech			
Post	Focus group: Math teachers		Teacher focus group: Use of engineering	
Day 3: AM	Classroom visits: non-STEM classes for STEM integration (2 researchers/class)			
	Student focus group: Technology use		Student focus group: Engineering	
PM	Accompany students to colleges		Accompany students to mentorships	
Post	Teacher focus group: Technology		Visit after school programs	
Day 4: AM	Meet school district reps		Meet with industry partners	
PM	Meet with college/university partners			
Post	Meet with administrators and facilitator for debriefing			

Data sources for each critical component in Exhibit 1 are shown below. We are mindful that each component needs multiple data sources for triangulation (George & Bennett, 2005), but also that collecting too much data is not feasible for the scope of the proposed work. The list below focuses primarily on the Implementation Dimension of Exhibit 2. Similar lists (data sources X Dimension and Context) for the Design and Outcome Dimensions have been developed, but proposal page limits do not allow their inclusion. The numbering system for critical components and data sources shown below corresponds to Exhibit 1.

1. **STEM-focused Curriculum** appraised by examining curriculum and pacing guides; scope and sequence documents provided by administration and teachers; structured interviews with principals and curriculum specialists; classroom observations of STEM and non-STEM classes (to determine STEM integration); and information about STEM opportunities outside the typical school day and year, ascertained by teacher and student interviews.

2. **Reform Instructional Strategies and Project-based Learning** assayed by interviews with administrators; teacher focus groups; student focus groups; and classroom observations using valid and reliable instruments such as *Reformed Teaching Observation Protocol (RTOP)* (Piburn et al., 2000) or *Instructional Strategies Classroom Observation Protocol* (O'Donnell, Lynch, Merchlinski, 2005); *ISIOP* scale for *Investigation-Related Experiences* (Minner & Delisi, 2010); and *Lesson Flow Classroom Observation Protocol* (Lynch & Hanson, 2005), a gauge of the time spent on student-centered activity in classrooms, adaptable for any subject matter including technology- or engineering-focused classrooms. We will also adapt some of the scales and codes developed by Nathan (2009) for video data that ask how classroom time is used in engineering classrooms, including how it is apportioned, and the emphasis on concepts vs. skills vs. integration of engineering concepts and skills.
3. **Integrated, Innovative Technology** gauged by existing valid and reliable technology surveys such as the *Technology Integration Progress Gauge* (SEIR*TEC, 2000); *School Technology Needs Assessment* (Corn, 2008) to be adapted for this study; and, observation protocols such as *Looking for Technology Integration (LoFTI)* developed by SEIR*TEC (2005).
4. **Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year** appraised by examining course syllabi; formal assignment rubrics; student project samples; teachers' records of participation in extended learning experiences; records of competitions and awards for projects beyond typical school day; student and teacher focus groups.
5. **Real-world STEM Partnerships** gauged by school website and MOU documents; interviews with principals, teachers and representatives from partner organizations.
6. **Early College-level Coursework** appraised by scheduling documents; student records; interviews with administrators, curriculum specialists and with educators from colleges involved; and, student focus groups.
7. **Well-Prepared STEM Teaching Staff** assessed by structured interviews with principals and teachers; and, examination of teacher CVs on file with the schools.
8. **Inclusive STEM Mission** determined by examination of promotional materials and websites; interviews with administrators and teachers; student focus groups; and comparisons of student demographic data at school level with that of school district.
9. **Administrative Structure** determined by organizational structure diagrams and other school documents, as well as interviews with school and school district administrators.
10. **Special Supports** rated by examining documents offering supports and rates of participation; principal interviews; and, teacher and student focus groups.

For the Outcome Dimension of Exhibit 2, we will collect data on indicators such as number of students taking college-level courses or working with mentors, or extent of student participation in learning experiences beyond the school day or year, using administrative records of such activities if available. We will also use district and state databases for attendance and graduation rates, and achievement on STEM-related district and state tests (above or below district and state averages) to provide comparable descriptive statistics for each ISHS. Such comparisons are rough estimates of the efficacy of an ISHS and do not take into account differences in students' achievement and STEM interest before entering high school. An effectiveness study is beyond *OSPrI's* scope; however, educators/policymakers often rely on such rough estimates of success.

Note that in January, 2011, a companion proposal will be submitted to NSF DRK-12 by Means et al. (of SRI) and Lynch (of GWU) that will mount a longitudinal, effectiveness study of ISHSs in three states, Ohio, North Carolina, and Texas; this longitudinal study is conceptually aligned with *OSPrI*, with Lynch and Means serving at co-PIs on both. However, neither study depends upon the other. But together, they can produce the most comprehensive view, to date, of the potential of ISHSs for STEM education reform.

Phase 2 Questions and Research Design: While the research goal in Phase 1 is to capture the critical components intended and implemented in 12 ISHS models, we also ask what an ISHS can provide aspiring STEM students, particularly students underrepresented in STEM fields, that is different from offerings in a typical comprehensive high school. Phase 2 of *OSPrI* will develop a systematic set of contrasts for both school options, including a set of comparisons from students' points-of-view. Phase 2 questions are:

- 5. How do 4 promising ISHSs compare with 4 matched comprehensive high schools within their respective school districts? How are critical components (in Exhibit 1) displayed in 4 comprehensive high schools, for Design and Implementation Dimensions, and Context?
- 6. From the points-of-view of students underrepresented in STEM fields, how do educational experiences and opportunity structures of ISHSs and comprehensive schools compare?
- 7. How does the student STEM Outcome Dimension (STEM test scores, grades, classroom and school climate indicators, and graduation rates) compare for comprehensive and ISHSs?

Phase 2 Methodology. Phase 2 will focus on 4 of the original 12 schools, and locate the "best-matched" comprehensive school counterpart for each in the same district. We will use cross-case analysis to compare the Dimensions in Exhibit 2 for each matched pair of schools, and focus deeply on student outcomes (Mason, 2002; Maxwell, 2005). We also will describe a "day in the life" (c.f., Lynch, 1993) of 2 ISHS students and 2 students with similar backgrounds attending the counterpart comprehensive high school. These comparisons will illuminate the educational experiences and opportunity structures in each school, weighing the offerings of an ISHS vs. a comprehensive school. The use of the multiple instrumental case studies method here will yield levels of understanding and interpretation within and across school pairs. Dealing with several case narratives and presenting them collectively will reveal patterns across cases, as we compose single, student-level narratives with unique features and context.

Sites, Samples, Recruitment and Incentives for Phase 2. Selection of 4 ISHSs for Phase 2 will be based on breadth and depth of implementation of ISHS critical components as determined in Phase 1; geographic location; a school district's willingness to participate (Stake, 1995); and, the quality of extant student databases for intra-school-district comparisons of student STEM outcomes. We will capitalize on relationships with the school district personnel developed in Phase 1 for permission to conduct comparative studies of matched pairs of high schools, providing the same incentives as for Phase 1. In Year 4, with school administrators' help, we will select 2 students from underrepresented groups in each ISHS school for individual cases studies, one 10th and one12th grade student per school. These students should be "typical" ISHS students who are making good progress in school and aiming at STEM-related careers. We will identify a counterpart for each ISHS student at the comprehensive school, matching on grade, demographics, GPA, highest middle school math course, and achievement on district/state STEM tests.

Data sources. For Research Question #5 (a comparison of ISHS and comprehensive high schools), we will gather information on each comprehensive school's' application of the critical components in Exhibit 1 for Design, Implementation, and Context, attending especially to the STEM participation of students in underrepresented groups. This will parallel Phase 1 studies of ISHSs, but with modifications for comprehensive high schools that are likely larger and more complex. The primary focus will be on STEM offerings and opportunities, e.g., asking what is the highest level math class offered in this school and how many and what types of students take it? For Research Question #6 (comparisons of STEM experiences and opportunity structures of 10th and 12th grade students), we will design interview protocols for target students, their peers, families, teachers, and other key persons involved in STEM education (mentors), guided by the identified critical components and additional elements that may emerge from Phase 1 of the study. For Question #7 (comparison of student outcomes for 4 pairs of ISHS and comparison schools within school districts), we will examine school district-level databases to compare STEM student outcomes, disaggregating data to reveal patterns for subgroups of students underrepresented in STEM. Such information is often in public records, but more nuanced understandings of school histories, demographics, contexts, and outcomes can be developed in collaboration with district administrators and evaluation personnel.

Procedures. In Year 3 of the proposed study, case studies of 4 counterpart comprehensive high schools will be conducted using similar case study methods as for ISHSs (see procedures for Phase 1).

For Questions #6 and #7, a second visit to the school districts will occur in Year 4. We will shadow 2 students for 2 days at the ISHS and the matched comprehensive high school. Rubrics developed by the researchers will ensure that students' perceptions of critical components are addressed in a systematic way (Miles & Huberman, 1994). Shadowing will illustrate how students with one school district experience STEM education in these two school environments, in an authentic way. To depict a typical day for a typical student (under-represented in STEM fields), we will interview their parents, teachers, and extra-curricular activity sponsors to paint a more detailed picture of their STEM experiences and opportunity structures. For instance, we will ask if students have STEM-related jobs outside of the school, participate in STEM social networks, or have realistic views of requirements for STEM college majors. Two researchers will be assigned to each student for two days. Other members of the research team will work with district personnel to gather descriptive statistics on student STEM outcomes, by student subgroup, for the two schools. This portion of *OSPrI* will result in 4 additional school-level case studies (comprehensive schools), and 16 student-level case studies for ISHS and comparison schools. Cross-case analyses of the 4 pairs of schools and the 16 students in them will provide a rich and nuanced view of the STEM opportunities and limitations for each type of school.

Analyses of Phases 1 and 2:

The goal of the Phase 1 analysis is to develop rich descriptions that showcase characteristics of each ISHS, resulting in a set of 12 instrumental case studies. We will also conduct a cross-case analysis to highlight commonalities across ISHSs and explore differences. Based on these analyses, we hope to build a singular theory of action for ISHSs, despite different school models, but we acknowledge that the evidence may lead to multiple theories. The goal of the Phase 2 analysis is to develop 4 rich comparisons of ISHS vs. comprehensive schools counterparts to allow a fair comparison of STEM experiences and opportunity structures for underrepresented students in those schools. Phases 1 and 2 should provide a full and multi-faceted view of ISHSs.

Phase 1. Treating each ISHS as the bounded system for description (George & Bennett, 2005) and using NViVO software, we will code the data for each ISHS in 3 stages. First, we will develop an initial coding structure based on components in Exhibit 1 and dimensions for Exhibit 2, supplemented by additional codes for context variables (e.g., district size). The study will also be open to other elements that site visitors see as important influences on implementation and outcomes. We will apply this coding structure to the complete set of data from all sources for each ISHS (Glaser, 1992; Strauss & Corbin, 1998). After reviewing all codes for an ISHS, we will rate each school on each element in the ISHS design, implementation, and outcomes dimensions, using either a yes/no or 4-point scale as appropriate for the element (e.g., school-within-a-school would be a yes/no variable while implementation of well-prepared STEM teaching staff would be rated on a 1-4 scale). Next, we will look for inter-relationships among variables. At this stage, we will be looking for core design and context variables that appear to influence implementation and outcomes. To inform this stage of the analysis, a debriefing meeting involving all site visitors will be held. Site visitors will suggest relationships observed at schools they have studied ("propositions"), and other *OSPrI* team members will indicate whether or not the same relationships were observed at other schools visited. This meeting will prepare analysts for *axial coding*. One open code will be positioned as the central piece of the process being explored (the core phenomenon) and relationships to other categories will be established (Gibbs, 2002). This will be used to identify core critical components that have a relationship with the other dimensions (e.g., *stand-alone ISHSs are characterized by higher levels of engagement with mentors than are schools-within-a-school*). Finally, a *theory of action* will be determined based on the interconnections from the axial coding phase (; Creswell, 2007; Glaser & Strauss, 1967). The theory of action will illustrate interconnections among context, design, implementation, and outcome elements, describing essential characteristics within and among ISHSs in a succinct and meaningful way.

Phase 2: Phase 2 will involve 4 sets of analyses. First, data for the comparison schools will be coded and analyzed using the same procedures described above for Phase 1. Second, the data gathered on individual students will be analyzed using a similar process. Information collected from field notes, rubrics, observation protocols, interviews of students, teachers, parents, and extra-curricular sponsors, will be organized and analyzed by individual student and by student matched pairs. The cases, as they are developed, will use a constant comparative method to test validity threats to the codes that emerge from the data (Maxwell, 2005). We will analyze student perceptions of the 10 critical components and others that emerged from Phase 1, as well as use emergent codes in our analysis (Glaser, 1992; Strauss & Corbin, 1998) to capture student perceptions of opportunity structures in their respective schools. This method will allow us to fully explore and categorize the experience of the school context through the words of student stakeholders. The codes will emerge mainly from the student data, but will be informed also by reports from the teachers, parents and sponsors who form a network around the student (Creswell, 2007). Third, data from existing databases within the school district will be used to analyze student outcomes for pairs of ISHS and comprehensive high schools. Fourth, research staff will convene to discuss the 3 analyses and assess affordances and constraints, in context, of ISHSs and comprehensive high schools for helping students to become STEM competent, confident of their abilities, and inspired to continue and succeed STEM fields.

DISSEMINATION

The *OSPrI* dissemination plan responds to recent calls for bolder education experiments: “The agencies (NSF and USDOE) should also promote the practice of research and development…and evaluation throughout STEM education entities so that policies are ultimately based on solid empirical foundations. At the same time, recognizing that it may take a decade or more to definitively prove the effectiveness of programs, the agencies should not be afraid to act boldly on the best professional judgment” (PCAST, 2010, p. 40). Because of the call to scale-up more STEM-focused schools (Obama, 2010), the fact that they *are* scaling up (Means et al., 2008), and the dearth of research on ISHS models or their effectiveness, the dissemination plan is two-pronged:

First, we will provide dissemination of the research findings as they emerge by creating an *OSPrI* website (similar to the SCALE-uP website--http://www.gwu.edu/~scale-up/-- a NSF-funded study led by PI Lynch) that tracks *OSPrI* study’s progress. The website will post the case studies of individual schools; records of instrument/rubric development and use; annual reports; and, conference proposals, papers, and publications. It will have links to ISHSs in the study (with permission), allowing education leaders, researchers, and policymakers to learn about research on ISHSs and particular models. We anticipate high interest in STEM school models, critical components, and the instruments used to capture them. We will disseminate via presentations to professional groups (Achieve, ASCD, Gates Foundation, NCSSSMST, NCTM, NRC, NSTA, and the *Opportunity Equation*). We will prepare an article for educational leaders in *Education Leadership* or *Kappan*.

Second, we will report and disseminate findings for peer-review to professional research organizations (AAAS, AERA, APA, ASEE, ITEEA, and NARST). Peer-review is crucial to the **intellectual merit** of this study, and we welcome scrutiny of cross-case analyses of the completed set of 12 school-level instrumental cases from Phase 1, and of Phase 2’s in-depth comparative cases that capture the experiences and opportunity structures for high school students in four pairs of high schools. Dissemination efforts will include both *OSPrI* and school-level staff whenever possible, developing new scholars and showcasing the practitioners who are creating ISHS, to maximize this study’s **broader impact**.

EVALUATION AND TIMELINE

The evaluation of this project will have three components: an Internal Advisory Board, an External Advisory Board and outside evaluators. The work of the two Boards is primarily formative. The evaluators will conduct an ongoing process evaluation providing feedback on research procedures and summarizing the Boards’ recommendations on an annual basis. The evaluators will also conduct a final, summative evaluation for submission to NSF.

Internal Advisory Board. Because this study focuses on STEM education, *OSPrI* will have a formative evaluation plan that includes STEM disciplinary experts. The Internal Advisory Board consists of professors from natural sciences and engineering who have some experience in K-12 education, but whose primary focus is on research and teaching in STEM disciplines. This group will meet biannually to discuss aspects of the project requiring expertise in STEM disciplines or interdisciplinary knowledge of STEM fields. It will review *OSPrI* research and offer views on case studies, trends, and cross-case analyses, and practical advice on ISHS activities and implications for STEM higher education. For instance, if ISHS students take STEM courses at local community colleges, this Board will advise the research team on the quality of the courses or explain their alignment with university STEM major sequences. Members include GWU professors Dan Ullmann (Mathematics); Hartmut Doebel (Biology); and James Hahn (Computer Science); and GMU professors Padmanabhan Seshaiyer (Mathematical Sciences); and Kevin Clark (Instructional Technology). See Letters of Support.

External Advisory Board. The purpose of the External Advisory Board is to connect *OSPrI* research with the world of STEM-focused schools and STEM education policy. It will meet annually, contributing to the formative evaluation of the project. Its members have special interest and expertise in STEM-focused high schools, and include: Francis Eberle, Executive Director of NSTA; Rena Subotnik, APA's Director of the Center for Psychology in Schools and Education and PI for a NSF-funded project on *selective* STEM high schools; Jerald Thomas, the immediate past president of the National Consortium of Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST) and professor of education at Aurora University; Kurt Becker, professor of engineering and technology education at Utah State University; and, Darnella Davis, formerly of the Cosmos Corporation (working with Robert Yin) who has extensive experience in evaluation of STEM programs at large scale and who will advise on case study methodology. The focus of this Board will include advising on appropriates measures and rubrics, refining research methods, and interpreting findings. This group will also help secure support for the project from ISHSs. See Letters of Support.

Exhibit 4. OSPrI Project Timeline

Note. Timeline assumes a Sept .1 start date; *PIs/Co-PIs will meet 2x/month by phone; M = In-person meeting.

Years	2011-12			2012-13			2013-14			2014-2015		
Semester	**F**	**Sp**	**Su**	**F**	**Sp**	**Su**	**F**	**Sp**	**Su**	**F**	**Sp**	**Su**
Sampling and Recruiting:												
School level ISHS	X	X										
School level Comparison					X	X						
Student level									X			
Instrument Development	X				X	X			X			
Case studies												
School level ISHS		M		M	X	X						
School Level Comparison								M	X			
Student level										M	X	
Analyses												
ISHS							X	X				
ISHS X Comparison									X	X		
Student level											X	X
Project Dissemination												
Website			X	X	X	X	X	X	X	X	X	X
Conference proposals			X			X			X			X
Papers/Reports			X	X		X	X		X	X		X
Conf. Presentations						M			M			M
Eval: Internal Adv. Board	X	X		X	X		X	X		X		
Eval: External Adv. Board		M			M			M			M	
Evaluation Friday Institute	X	X	X	X	X	X	X	X	X	X	X	X
Project Management*	X	X	X	X	X	X	X	X	X	X	X	X

External Evaluators (Qualitative Methodology Experts). *OSPrI*'s formative and summative evaluation will be led by Dr. Kevin Oliver and Dr. Jenifer Corn of the Friday Institute for Educational Innovation at the College of Education at North Carolina State University. This group has considerable expertise in school-level evaluation on innovations in K-12, using both qualitative and quantitative research designs. The evaluators will work collaboratively with the Internal and External Advisory Boards for this project, incorporating their feedback. The formative, process-focused evaluation will document and analyze the implementation of the study (when activities occur and who performs them) and unanticipated issues that arise and how they are resolved. The evaluators will attend Internal Advisory Board meetings via Skype and contribute to their agendas, and lead the annual meetings of the External Advisory Board. Feedback from meetings will be incorporated into summaries to be used formatively by the project team to guide decisions about research design and implementation. Drs. Oliver and Corn will write a summative evaluation report for a final report to NSF. See Exhibit 4 for overview of *OSPrI* timeline.

EXPERTISE AND MANAGEMENT STRUCTURE

The *OSPrI* project design and execution will be the responsibility of senior research team led by PI Sharon Lynch (GWU) and co-PIs Tara Behrend (GWU), Erin Peters Burton (GMU), and Barbara Means (SRI). This team includes 2 researchers (Lynch and Means) with considerable management expertise as PIs of NSF projects, and 2 new co-PIs (Behrend and Peters Burton) who have experience in other NSF-funded projects. The project will hire a full-time Senior Research Scientist with a doctorate in mathematics education to manage the project and participate in the research efforts focusing on mathematics teaching and learning, and education and the integration of mathematics in ISHSs. In addition, Jere Confrey (North Carolina State University), a mathematics educator and researcher and co-author of the SRI STEM school study (Means et al., 2008), will contribute to the research design, consult on the mathematics aspects of the study, and act as liaison to the mathematics education and policy communities. Ann House (SRI) has extensive expertise conducting instrumental case studies. Junior project staff will include 3 research assistants with expertise in science, technology and engineering education, resulting in a team that can send 4 researchers, one in each area of STEM, to a school for on-site data collection, as well as collect pre-visit data, write case studies, and help conduct cross-case analyses.

Each case will be directed by a member of the senior team. In addition to the knowledge that Means brings to the project in STEM and technology education/policy, she and SRI colleague Ann House will provide methodological expertise in conducting multiple instrumental case studies. Each senior team member will lead the development of measures/rubrics for a portion of the 10 critical components, but the entire team will be trained to use them on-site. Weekly meetings of the team will ensure coordination; SRI partners will join us via Skype, on school visits, and at annual meetings of the External Advisory Board as well as at conferences.

Principal Investigators/Senior Staff/Other Staff:

PI Dr. Sharon J. Lynch's research is on science education, equity and policy issues. She has written a book on this subject, *Equity and Science Education Reform* (2000), updated by a new chapter in a science education policy book (Lynch, in press b). Lynch received 2 IERI awards to conduct interdisciplinary studies on the effectiveness and scale-up of middle school science curriculum materials and their effects on underrepresented demographic subgroups of students. Ethnographic data and implementation fidelity measures showed how the materials worked and for whom, leading to published work about scale-up and implementation. Lynch has also been a secondary school science teacher (biology, chemistry, environmental science). Lynch will serve as the lead for the project, working collaboratively with co-PIs and the project manager. **Co-PI Dr. Barbara Means** is co-director of SRI's Center for Technology in Learning. Her research focuses on the evaluation of innovative educational strategies designed to foster students' learning of advanced skills. She led the literature review, conceptual framework development, and survey of STEM-focused high schools for the Gates Foundation. Dr. Means served on the National Academy of Sciences' Committee which produced *How People Learn.* Her published works include edited volumes *Evaluating Educational Technology*, *Technology and Education Reform*, and *Teaching Advanced Skills to At-Risk Students.* As Co-PI Means will participate in project planning and design meetings, selected school site visits, and data analysis and reporting. **Co-PI Dr. Tara Behrend** is an Assistant Professor of Industrial/Organizational Psychology in GWU's Department of Organizational Sciences and Communication. Her research focuses on the ways information technology can be leveraged to enhance individual and organizational performance. She has conducted research funded by the State of North Carolina and IBM on the successful implementation and use of technological innovations in community colleges. She will bring a similar perspective to this work, examining the ways that teachers, students, community and contextual factors influence the successful implementation of ISHS critical components relating to technology use. **Co-PI Dr. Erin Peters Burton** is Assistant Professor of Ed Psychology and Science Education at GMU. She conducts research in cognition of science, self-regulation of scientific epistemologies, social justice in science education, and assessment of nature of science. She is Co-Investigator on NSF's CCEP project, *Making the Global Local - Unusual Weather Events as Climate Change Educational Opportunities*, and is on the Leadership Team for a NSF-funded ITEST grant *Game Design Through Mentoring and Collaboration.* Peters Burton has won teaching awards, including Presidential Awards for Excellence in Science and Mathematics Teaching. Given, her experience as an electrical engineer and Albert Einstein Distinguished Educator Fellow at NASA, she will focus on engineering aspects of the study. **Dr. Ann House,** a research social scientist at SRI's Center for Technology in Learning, is an expert on comparative instrumental case studies. She worked on the T-STEM Initiative in SRI's evaluation of the Texas High School Project and on a national study surveying principals of STEM schools. **Dr. Jere Confrey**, Professor of Mathematics Education at NCSU is a well-known mathematics educator who will work with *OSPrI* on research design and connecting policy issues in mathematics education with ISHSs, including implementation of the Common Core Standards in math; she is well-acquainted with STEM school models through her earlier work with SRI study of STEM schools. **A Senior Research Scientist** with research and management experience, and a doctorate in mathematics education, will be hired to direct the study. **Junior Staff** will consist of 3 research assistants who are doctoral students, one each in science, engineering and technology education.

RESULTS OF PRIOR NSF SUPPORT

Sharon Lynch was the PI for two research grants (NSF 0115637 and NSF 0228447) funded by the Interagency Educational Research Initiative (IERI). IERI focused on the scale-up of education interventions. Lynch led the *Scaling up Curriculum for Achievement, Learning, and Equity Project (SCALE-uP)*, an interdisciplinary collaboration between STEM education experts, linguistic anthropologists, and Montgomery County (Maryland) PS science educators on the characteristics of effective middle school science curriculum materials for diverse student subgroups, contributing to new conceptions of fidelity of implementation. The *SCALE-uP* website is still active and generates new research efforts for secondary data analyses. S*CALE-uP* resulted numerous publications (Lynch, et al., 2005; Lynch et al., 2007; O'Donnell, 2008; Rethinam, Pyke, & Lynch, 2008), including two chapters focusing on scale-up and implementation of science education curriculum materials (Lynch, in press b; Lynch et al., 2007).

OSPrI Co-PI Dr. Means served as PI or co-PI for 3 grants evaluating the GLOBE environmental science education program (ESI-9802033), focusing on implementation in different contexts and understanding the conditions that support effective scaling (Coleman & Penuel, 2000; Means & Coleman, 2000; Means & Penuel, 2005; Penuel et al., 2009; Penuel & Means, 2004). Means was Co-PI of a project (ROLE-0231981) that explored social network analysis to test how education reforms were taking hold in schools (Penuel, Frank, & Krause, 2006; Penuel & Riel, 2007). She was PI for a REESE synthesis project (0635639) on the cognitive, curriculum, and intervention research on secondary mathematics learning for below-grade-level students. Currently, she is PI for a study of afterschool programs (ISE-0917536) that examines the role of intermediaries and social capital in the spread of high-quality science learning materials.

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