A Review of the Literature and the INSPIRE Model
STEM in Out-of-School Time
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National Institute on Out-of-School Time
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Introduction

"Preparing today's children to be tomorrow's scientifically engaged adults requires that all children have opportunities to learn and practice science, develop scientific ways of thinking, and in some cases become the scientists who will help to create our future." (Coalition for Science After School, 2007)

Summary and Methods

This review conducted by the National Institute on Out-of-School Time (NIOST) explores the current discussion and research findings on STEM (Science, Technology, Engineering, and Math) in out-of-school time and reflects on the ways the INSPIRE program model (see Appendix A) incorporates research-based practice in implementing STEM education experiences in out-of-school time. The purpose of the literature review and analysis project is to inform the INSPIRE program managers during the planning and implementation stage of INSPIRE.

It is not surprising that there is little research literature that explores the implementation of STEM experiences in out-of-school time. While there are substantial research findings on the teaching and learning of STEM drawn from classroom-based settings, less work has been done to explore STEM teaching and learning experiences in out-of-school time settings. However, several significant research projects are underway and knowledge about STEM in out-of-school time will continue to expand (see Appendix C).

Several types of organizations such as museums, science centers, and colleges have historically offered opportunities for children and youth to explore STEM. However, over the last ten years substantial effort has been made towards including STEM experiences in more traditional out-of-school time program settings. Concerns over weak national academic progress in STEM fields and acknowledgement of underrepresented and underserved groups in the STEM pipeline, have fueled interest in providing engaging and inspiring STEM experiences in the broadest variety of youth settings.

For this literature review the researchers conducted a Web document search as well as used several electronic databases to search for recent journal articles, reports, and papers. The researchers also employed several additional data collection strategies, including e-mail and phone interviews with STEM in out-of-school time related advocates and researchers. The researchers reviewed NIOST's extensive library, including books, articles, research briefs, conference proceedings, and other information related to research on out-of-school time and STEM. We also reviewed Web sites and documents from national organizations such as the Coalition for Science After School; Cooperative Extension Service: Children, Youth, and Family Network; Southwest Educational Development Laboratory; National Afterschool Association (formerly NSACA); Forum for Youth Investment; National Science Foundation; Afterschool Alliance; Mid-Continent Research for Education and Learning; National Center for Education Statistics; and EDC (Education Development Center, Inc.).

In total, we selected 84 documents for initial review. This final paper incorporates information from 57 of the originally selected documents. The researchers primarily focused on literature and research published within the last 10 years, and those that reported on evaluation or research findings from a particular STEM initiative or included teaching/learning methodology information that could inform the INSPIRE initiative.

This paper begins with a discussion of the need for STEM education in the out-of-school time hours and participation experiences in STEM education. The second section presents the recent research on out-of-school time programs and youth outcomes. Section Three explores the literature and research which points to: (1) what we know about learning STEM in out-of-school time; (2) what we know about teaching STEM in out-of-school time. Section Four discusses some of the key issues in attracting middle school youth to out-of-school time programs. The final section, Section Five, discusses implications for STEM in out-of-school time and the INSPIRE model.

Section 1. Background and Participation for STEM

During the past 25 years there has been a significant increase in the need for a more highly trained workforce to meet the needs of the changing world of technology. In order to stay competitive in the global economy, the United States must nurture a more technically and scientifically capable youth population. The U.S. National Commission on Math and Science suggests that "The future well being of our nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science specifically" (Bevan & Semper, 2006; Catsambis, 1994; Froschi et al., 2003; United States Department of Education, 2000). United States children continue to lag behind their counterparts in other countries in STEM (Bevan & Semper, 2006; Kuenzi, et al., 2006).

In addition to declining preparation of youth in STEM academic areas, youth participation is uneven across race and gender. By the time youth reach the 8^{th} grade, regardless of race and ethnicity "twice as many boys are interested in quantitative disciplines and science careers than girls" (Campbell, et al., 2002; Catsambis, 1994). Studies of the U.S. workforce point to the severe shortage of females and minorities advancing in STEM academic and career areas. Underrepresented groups comprise nearly two-thirds of the overall U.S. labor force, yet they make up one quarter of the science and engineering work force (Campbell, et al., 2002). Currently African Americans and Latinos comprise less than 9% of the workers in the physical sciences and Native Americans less than one percent (Campbell, et al., 2002; National Science Foundation, 2000). However, by the year 2008, underrepresented populations will make up more than 40% of the new workforce entrants (Campbell, et al., 2002). Declining interest of underrepresented groups in STEM greatly impacts the quality and quantity of qualified workers entering the workforce.

While many school systems have particularly focused academic enrichment and support programs towards enrolling and supporting diverse youth in STEM exploration and learning initiatives, these same youth are not necessarily staying engaged at the post-secondary level and beyond. Recently educators have increasingly looked to out-of-school time programs and other informal learning settings for supporting and encouraging youth in STEM. The following section presents recent findings related to participation in out-of-school time programs and youth outcomes. This information is helpful by pointing to the connections that have been suggested between out-of-school time program participation and positive youth outcomes. Such information is helpful for setting outcome expectations for the INSPIRE program and particularly the Junior Explorer and Junior Guest Researcher tiers.

Section 2. Summary of Research on Out-of-School Time and Youth Outcomes

The "America After 3 PM" survey findings indicate that approximately 6.5 million (11% of the 57 million youth in grades K-12) participate in out-of-school time programs (Afterschool Alliance, 2004). Participants spend about 8 hours per week in out-of-school time programs.

There is significant research that suggests participation in out-of-school time programs is positively associated with better school attendance, more positive attitudes towards school work, higher aspirations for college, finer work habits, better interpersonal skills, reduced drop-out rates, higher quality homework completion, less time spent in unhealthy behaviors, and improved grades (Clark, 1988; Hamilton & Klein, 1998; Huang, Gribbons, Kim, Lee, and Baker, 2000; McLaughlin, 2000; Posner & Vandell, 1994, 1999; Schinke, 1999; U.S. Department of Education, 1998). Out-of-school time programs can offer intangibles such as: "the opportunity to engage in activities that help young people realize they have something to contribute to the group; the opportunity to work with diverse peers and adults to create projects, performances, and presentations that receive accolades from their families and the larger community; and the opportunity to develop a vision of life's possibilities that, with commitment and persistence, are attainable" (Miller, 2004, p. 9).

In a meta-analysis of 56 studies of out-of-school time programs, researchers at McREL found that out-of-school time strategies can have positive effects on the achievement of low-achieving or at-risk students in reading and mathematics; that the timeframes for delivering out-of-school time programs (i.e., after school or summer) do not influence their effectiveness; and that out-of-school time strategies need not focus solely on academic activities to have positive effects on student achievement (Lauer et al., 2003).

Nationally, schools are finding it increasing difficult to meet academic standards as implemented through national and local legislation. Current emphasis on high stakes testing and raising student academic achievement has put pressure on out-of-school time programs and providers to demonstrate, primarily to funders and policymakers, the role out-of-school time programs can play in supporting classroom learning and academic improvement. Such developments have brought out-of-school time program providers into new models of partnership and shifted priorities in program content and delivery. In light of these trends it is not surprising that out-of-school time programs have been looked upon to provide substantial learning opportunities related to STEM experiences.

The development and implementation of INSPIRE is consistent with other attempts to support STEM education through inclusion in informal learning settings. Although the research in the area of STEM education in out-of-school time is still nascent, reports on program implementation and available research offer valuable insights into key program elements and delivery strategies. The following sections outline current findings on learning and teaching STEM in out-of-school time.

Section 3. STEM in Out-of-School Time Research Findings

What We Know About Learning STEM in Out-of-School Time

Informal educational settings such as science museums have been providing experiential STEM learning opportunities to youth for many years. More recently, the landscape of afterschool programs has changed to include STEM learning opportunities during the out-of-school hours. Because STEM learning and teaching in out-of-school time is still relatively new, research and data collection relating specifically to STEM learning in out-of-school time is limited, and even less data is available that reflects the effectiveness of specific program aspects aimed at increasing participation in STEM among underserved populations. Broad differences exist between programs in areas such as staff preparation, available resources, learning goals, and participation levels. However, research findings do show some similarities in the ways in which youth seem to most successfully engage in STEM education experiences.

The After-School Corporation reports that afterschool programs help youth engage in scientific inquiry by helping them to develop critical thinking and problem-solving skills through project-based experiential learning (Campbell et al., 2002; Davis and Rosser, 1996; Froschi et al., 2003; Hansen et al., 1995; Koch, 2002; Lee, 1997; Wenglinsky, 2000). Youth are natural explorers and when provided opportunities to investigate objects and their relationships using multi-sensory approaches, they become intrinsically motivated, ask more questions, make connections between the real world and theory, develop new ideas and interests, and learn to think outside the box (Bird, n/d; Ramey-Gassert, 1997; Walker, et al., 2005) . When an activity is interesting and fun, youth engage longer which helps deepen their understanding.

Hands-on learning environments have been found to boost interest and achievement in science (Campbell et al., 2002; Davis and Rosser, 1996; Froschi et al., 2003; Hansen, et al., 1995; Koch, 2002; Lee, 1997; Wenglinsky, 2000) and “active participation or personally interacting with new material increases the acquisition and retention of information”

(Madden, 1985; Ramey-Gassett, 1997). Programs that encourage self-inquiry have been shown to help promote and raise self-confidence and self-esteem in girls. The Coalition for Science After School (2007) concluded that "afterschool settings are optimal for providing engaging hands-on STEM experiences ...that can extend skills taught in schools...through project-based activities...where a variety of children can participate in the design and construction of the activities." Although much of the research supports hands-on exploration as key to understanding, the Science Guidelines for non-formal education reminds program developers that "hands-on activities without minds on engagement" does little to help youth "reconstruct their understanding," and develop critical thinking skills and new ideas. Without meaningful learning the activities are "merely entertaining activities for youth" (Carlson & Maxa, 1997; Raizen, et al., 1995). The National Council for Research on Women reviewed out-of-school time programs aimed at "increasing participation in STEM by girls and minorities" and found that underserved populations do best in "environments that encourage hands-on research, with qualified mentors who also serve as role models" (Collins, 2003; McClure & Rodriguez, 2007).

Research by Basu & Barton (2007) found that urban youth developed an interest in science when "their experiences were connected with how they envisioned their future." The ASPIRA programs provide education and leadership development in afterschool and summer programs to schools with high concentrations of Hispanic middle school and high school girls. The programs seek to improve academic achievement and interest in STEM by offering math, science, and technology topics in unique and exciting ways and introducing youth to a variety of professional and postsecondary opportunities. Data results indicate that 90% of participants continue their education in college or post-secondary STEM training (Aspire Association, 1995).

Some research suggests that helping underrepresented populations connect science to real-world events can develop and foster interest in STEM for life-long learning. Many programs that provide these experiences to youth have had successful outcomes. Project Exploration, created in 1999 is a program designed to increase STEM participation of underserved populations in Chicago. Three youth programs based on a social-constructivist model of learning were developed to engage youth in hands-on activities that build strong interpersonal relationships with participants and adult mentors. Evaluation reports indicate that 33% of girls participating later majored in science in college (Project Exploration, 2006). For the past six years, Hampshire College has offered an afterschool science club to middle school girls. The program uses inquiry-based constructivist learning activities to enhance science and math skills and provides role models who inspire and encourage the girls to think like scientists. Program evaluations show that many of the participants who perform poorly in traditional settings often excel in the science club (Murrain, n/d).

A study conducted at the University of Michigan Institute for Research on Women and Gender used data that was collected for over 17 years and found that although girls underestimate their abilities in STEM, "what pushes girls away from mathematically based majors is how much they believe in the ultimate utility of mathematics and how much they value working with and for people" (Science Daily, 2003). Eccles suggests developing interventions that will align STEM careers with the experience of helping people, could be a strategy for encouraging girls to enter STEM careers (Science Daily, 2003).

Much of the literature suggests that quality mentors are a key ingredient to successful STEM leaning, especially for underserved populations. Mentoring and role modeling can increase interest in science for girls and help "counter sexist attitudes" (Campbell & Steinbrueck, 1996; Ferreira, 2001) in addition to raising girls' confidence and participation in STEM activities. The Society of Women Engineers and Exxon Mobil Education Foundation initiated an afterschool science program in 1999 to serve urban minority females, specifically to study the effects mentors had on increasing attitudes towards STEM. The girls worked directly with female engineers through cooperative hands-on learning projects. Program evaluations showed positive change in student attitudes towards STEM learning and careers.

In 2003, SECME RISE introduced a three-year program to middle school youth using mentors and hands-on learning experiences. The purpose of the program was to reduce attrition and sexist attitudes through advanced level STEM coursework. Survey results reported that 86% of participating youth planned on pursuing careers in STEM (Campbell & Steinbrueck, 1996; Ferreira, 2001).

Findings from the literature show that programs that provide underserved populations with the opportunity to engage in scientific discovery where they can build upon pre-existing knowledge and make connections to real world applications, have increased student self-confidence and interest in science (Basu & Barton, 2007; Campbell and Steinbrueck, 1996; Ferreira, 2001; McClure & Rodriguez, 2007). YES in St. Louis has been providing science learning to low-income and minority teens since 1997. YES provides youth with inquiry-based science learning and trains teens to participate as peer teachers in other community and afterschool programs. After completing the program youth are eligible for employment opportunities. Program evaluation reports show that 24 of the 35 high school seniors enrolled in the program continued their education in the medical or teaching fields (McClure & Rodriguez, 2007).

Research shows that learning environment plays a key role in achievement for underserved populations in STEM learning (Fancsali, 2002; McClure & Rodriguez, 2007). Traditional classroom settings can hinder the natural inclination of girls to socialize and work in collaboration with others. Research suggests that programs that offer girls the opportunity to work in small groups help to foster self-confidence and contribute to increased levels of risk-taking, engagement, and participation. Studies show that girls prefer to work in small groups where they can work in collaboration with others to develop social relationships, discover connections, and make associations among objects (Fancsali, 2002).

Researchers suggest that out-of-school time programs can increase STEM participation of minority youth by establishing strategic alliances with community science resources and through field trips that help them to explore and make connections within their local communities (Fancsali, 2002). Additionally STEM learning can be enhanced by visits to local colleges, labs, science museums, and by providing career counseling to help youth see the "relevance of science in the broader context of life" (Kahle, 1996 as cited in Fancsali, 2002).

What We Know About Teaching STEM in Out-of-School Time

As the landscape of out-of-school time programs change, out-of-school time staff are increasingly called upon to support educational achievements by providing youth with enrichment opportunities to support their learning. There is very little in the literature on STEM in out-of-school time which evaluates staffing models for delivering STEM experiences in out-of-school time. Noticeably absent from the research literature are findings related to how staff prepare to teach or are trained in STEM related materials in out-of-school time programs.

Out-of-school time program staff members enter the field with a variety of educational backgrounds. Many are ill prepared to meet the increasing demand to enhance STEM learning for the youth they serve. Although the diversity of "knowledge, experience and background" of out-of-school time staff contributes to positive youth outcomes, research strongly suggests a need for more formalized training in STEM in out-of-school time (Dennehy & Noam, 2005). Some research has found that in "programs with more highly educated staff" youth were more likely to achieve higher outcomes due to the quality of the services received (Fashola, 1998).

In contrast, some studies suggest that the lack of science training for out-of-school time staff presents staff with the opportunity to "explore with the children" and "embrace new learning techniques and styles" where staff can "incorporate youth development into science" (Walker, et al., 2005). Staff can become co-inquirers and encourage youth to develop "more assertive roles in experimenting," providing staff with alternative methods of exposing youth to new concepts and ways of thinking. However, some research notes that staff who lack proficient training, experience, or education may gravitate towards familiar activities rather than activities that youth may find more interesting (Subtnik, Rayhack, & Edmiston, n/d).

As reported in the 2004-2005 21st Century Community Learning Center (CCLC) program evaluation, the majority of 21st CCLC out-of-school time programs are staffed by certified teachers (McClure & Rodriguez, 2007). Elementary school teachers make up the largest percent of out-of-school time staff, yet only 22% report having their degrees in specific academic content including STEM (McClure & Rodriguez, 2007). Researchers report that only 25% of licensed elementary school teachers felt qualified to teach science in general, with most reporting feeling unprepared to "develop students conceptual understanding, lead students in using investigative strategies, and help students to make connections between science and other disciplines" (Knapp, 2007).

Certified teachers working in out-of-school time programs most often have the experience and training to create lesson plans aligned with day school learning. However, few have specific training in teaching science. Middle school science teachers felt more prepared to engage students in hands-on work, and develop conceptual understandings of science.

Few middle school teachers, though, reported feeling qualified to teach specific science concepts (Dennehy & Noam, 2005). Additionally, many school teachers have difficulty making the transition of working in a structured setting to the relaxed atmosphere offered in most out-of-school time settings.

High-turnover rates among out-of-school time staff is a consistent challenge for programs. The high turnover rate affects the ability of staff to form bonds and develop relationships with youth which research shows is vital to "attracting and retaining youth participation" and successful youth outcomes (Dennehy & Noam, 2005). Research suggests that out-of-school time staff can compensate for their limited "credentials or years of experiences" by forming bonds and developing supportive relationships with the youth (Miller, 2003; Seidel, et al., 2002). What out-of-school time staff may lack in training they often compensate for by providing youth with essential motivation, desire, and encouragement to create hypotheses and view science through a different lens (Dennehy & Noam, 2005).

The research and literature focused on teaching STEM in out-of-school time points to several teaching strategies as particularly effective in engaging youth including activity-based exploration and project-based learning. Out-of-school time program staff serve as facilitators by introducing activities, distributing materials, and providing just enough instruction to engage youth in exploration and discovery. Staff stimulate engagement by helping youth make connections and arrive at insights on their own. Staff direct youth to information that they need to further their exploration without providing answers (Walker, et al., 2005). In offering project-based programs, the role of the staff is to support youth in discovery by introducing a project; explaining the process; and instructing on proper use of instruments, materials, or techniques needed for a successful outcome.

Programs which include STEM field professionals as mentors to facilitate lessons have demonstrated successful student engagement, especially for underserved populations (Froschi, et al., 2003). Mentors offer youth the support and encouragement that research shows is effective in helping underserved populations increase exploration in science and increase their ability to take risks (Fancsali, 2002). In the program Girls Inc., girls work side-by-side with scientists, engineers, and other professionals who help them gain the confidence to explore STEM activities and develop their interest in STEM careers (Walker, et al., 2005).

The following section shares key findings from research on middle school out-of-school time programs. While INSPIRE includes students through their freshman year in college, original connection with students is made as 7th graders. Information on effective middle school out-of-school time programs may inform recruitment and implementation strategies for INSPIRE.

Section 4. Key Issues in Attracting Middle-School Youth in Out-of-School Time

Reports from out-of-school time programs commonly state the substantial challenge of sustaining the interests of middle school and high school youth in out-of-school time programs. Research in the out-of-school time program field shows that program participation drops off in middle school, ostensibly because older youth are not interested in formal out-of-school time programs and parents are more likely to leave youth in self-care (Forum for Youth Investment, 2003). Some research though suggests that many youth would actually prefer to participate in structured activities should they be available. One study observes that nationally, more than half of teens wish there were more community or neighborhood-based programs available after school, and two-thirds of those surveyed said they would participate in such programs if they were available (Penn, Schoen & Berland Associates, 2001).

Researchers from the University of California Cooperative Extension and the University of Maryland Cooperative Extension have investigated the characteristics of successful middle school out-of-school time programs (Dyson, 2004; Murdock & Go, 2002). There is consensus in their reports that successful middle school out-of-school time programs: (1) provide meaningful activities; (2) allow youth “to do” for themselves; (3) give opportunities to work in groups and socialize; (4) share decision-making power with youth; (5) offer a flexible program structure; and (6) provide mentoring and coaching relationships with older youth and adults. Research by Westmoreland, Little and Gannett (2006) adds that family connections are important in middle school programs to bridge the often compartmentalized life of middle school students and to strengthen sometimes tenuous parent/youth relationships.

Section 5. Implications for STEM in Out-of-School Time and the INSPIRE Program

It is clear from the research and literature that a need exists to increase the preparedness of today’s youth in STEM related education to fill the increasing demands for a high quality workforce. Additionally, there is the challenge of increasing participation of currently underrepresented populations in STEM education and careers. The research shows that out-of-school time programs can play a significant role in increasing youth’s interest and participation in STEM.

Out-of-school time programs that intentionally focus on promoting STEM have shown some success in increasing both achievement and interest in STEM. Although the research on STEM in out-of-school time is still underdeveloped, program leaders should be encouraged by the positive trends that are evident in current research findings.

The selected approaches for the INSPIRE model for younger youth are primarily exploration and mentoring. Early participation emphasizes exposure to STEM experiences and professionals. Promoting participation by families is also seen as a mechanism to support deeper commitment and long-term continuation in the program (participation from tier 1 through tier 3). The model reflects Bronfenbrenner's (1978) ecology of human development theory by focusing on supporting connections between the variety of settings that youth encounter including schools, informal science organizations, civic groups, colleges, etc.

The approach for older youth and college freshman shifts to direct instruction, inquiry-based learning, and work-based learning. The intent of this later experience is to communicate a body of knowledge and skills, while also inspiring continued advancement in the STEM field. The choice of these approaches should consider the available findings from the STEM in out-of-school time literature and research. There are several key findings that carry important implications for the INSPIRE program. The following sections illuminate these findings and their connection to INSPIRE.

Hands-On Learning and Informal Education Organization Relationships

Learning in out-of-school time looks very different than learning in day school. This applies to STEM education, also. Out-of-school time programs have the unique ability to accommodate differences in youth's learning styles and the ways they acquire and process information. Hands-on approaches which are typical of learning in out-of-school time settings have been found to increase interest and engagement and are a key factor in helping youth develop critical thinking skills. The literature suggests that when youth manipulate objects, they engage longer and form an understanding of how things work. Through this exploration they ask more questions, develop strategies to problem-solve, and incorporate other skills into their learning which leads to a deeper understanding of the material.

It would seem particularly important that exploration activities offered as part of the Junior Explorers tier (grade 7-10) be very inclusive of hands-on learning activities and meet a variety of learning styles. While connection to enthusiastic and inspiring researchers and engineers is desirable, it is not sufficient alone to engage the interest and commitment of middle and high-school age youth. It would also make sense to substantially utilize connections already in place to informal education organizations such as museums, Boys and Girls Clubs, faith-based organizations, etc. While this is already in the implementation plan, the extent to which these relationships will be used is not clear. Since these organizations typically operate with a "youth development" philosophy and apply a "hands-on" learning approach, in addition to being successful at attracting and maintaining participation from teens and underrepresented populations, it would be valuable to stretch these relationships in all ways possible. Some examples of this may be utilizing youth organization staff as co-facilitators, adapting effective procedures from youth organizations, and creating similar learning environments/spaces that have proven successful for these organizations.

Mentoring

Underrepresented youth have increased difficulty envisioning themselves in STEM careers because of few available role models. The use of mentors and roles models in STEM focused out-of-school time programs has been shown to be effective in helping youth imagine themselves as scientists. Introducing youth to career alternatives through the use of mentors and role models has been shown to have a powerful effect on changing attitude in youth perceptions of themselves and can help them to envision themselves as scientists, engineers, etc. Research findings suggest that programs that target specific populations and provide role models that emulate participating youth in gender and ethnicity can raise self-esteem and confidence levels and change the negative attitudes towards participation in STEM activities and careers. The literature strongly suggests that the most effective role models for girls are women. In general, youth are more apt to envision themselves in a STEM related career if their mentor reflects a similar ethnicity/race/culture.

Mentoring is a key feature of the Junior Guest Researcher tier and the Collegiate Intern tier. The planned use of mentors/role models should help youth make connections between their own lives and potential careers in STEM. However, it will be a key challenge for INSPIRE to provide mentors who match the profiles of targeted youth.

Self-Directed and Group Learning

Although many programs report youth are more motivated to continue STEM related exploration when it is self-directed and guided by the intrinsic desire to deepen their understanding, research in this area is still too underdeveloped to offer confirmation. Findings from programs that develop a pre-set curriculum compared with programs where exploration is self-directed in STEM activities report equal levels of interest and exploration among participating youth.

What appears to be valuable in inspiring youth to explore STEM is working in collaboration with others. Sharing ideas and discussing approaches provides youth with the opportunity to learn from each other. Promoting peer collaboration and small group work as part of the Junior Guest Researcher tier would seem to be a valuable choice. This tier already includes working as part of a research team. Efforts to make the research team experience as genuine and authentic as possible, along with including other junior research peers as part of the research team would make sense. When programs offer youth the ability to link learning experiences with their peers and to meet and engage with other youth with similar interests, youth may be more likely to support and encourage one another to take risks and explore interests more deeply.

In order to be more effective many youth development organizations and out-of-school time programs have become more aggressive in capturing youth feedback and voice. It would make sense as part of the evaluation strategy during each phase of the INSPIRE program to include some mechanism that collects information from students on student experience and suggestions for program improvement.

Incorporating Out-of-School Time Program Staff

Out-of-school time program staff that represent diverse experiences and backgrounds offer youth qualities and skill sets that should not be overlooked. Often non-program professionals are not trained in youth development and their instructing/facilitating style can resemble classroom teaching. Youth can feel intimidated if they cannot connect with them, and may withdraw for fear of judgment or isolation. Research has shown that connections with caring and nurturing staff are a key element in effective out-of-school time or informal learning environments.

Out-of-school time programs traditionally offer a more holistic learning approach than school which addresses cognitive, social, and emotional development. When older youth feel that they are accepted and respected for who they are, they are less resistant and more willing to try new experiences.

Each tier of the INSPIRE program offers exposure to NASA researchers and engineers. This mentoring and modeling element of the program is a valuable asset. Program managers will also want to intentionally look for ways to include out-of-school time program staff into the learning and facilitation experiences. Team-teaching and small-group work with facilitation support from out-of-school time program staff might be successful ways of combining the resources of both sets of adults.

Out-of-School Time and Not More School Time

A key point in the development of programs designed for the out-of-school time hours is that out-of-school time programs, including those that focus on STEM, should not look and feel like traditional school. Many aspects of the INSPIRE model may resemble traditional day school learning and therefore may not stimulate engagement in the ways expected. Out-of-school time programming for middle school and high school youth, in particular, needs to be delivered in a way that provides youth with opportunities for choice, independence, flexibility, and social experience.

It would also seem important to create an atmosphere where youth can make mistakes without fear of judgment and without the pressure of time. Extending time-on-task will accommodate different learning styles and help promote learning with understanding.

To some extent INSPIRE is attempting to engage and excite students who have not yet locked into a career pathway focused on STEM. Previous educational experiences and settings may have fallen short in stimulating the right connection. INSPIRE will want to look and feel different than those prior experiences and settings in order to engage students in STEM in new ways.

Connections to Family and Local Environment

Family and community involvement has been shown to greatly impact youth's participation in STEM. Several program models examined for this paper which, included family and community integration, showed high levels of success.

When youth feel encouraged and supported by families, they feel that their participation in a STEM field is validated and accepted and that they "can do" science or math. Conflict can exist for youth who are faced with the decision of fitting into a community/family culture and simultaneously exploring a pathway that does not fit within the perceived family cultural norms. Often youth feel a cultural allegiance to stay connected to the norms of their community rather than renegotiate their familiar relationships and roles.

Many INSPIRE participants at the Collegiate Intern level may be the first in their families to attend college. There is significant research on first generation college students (London, 1996; Terenzini, 1994) which suggests that going to college constitutes a major disjunction in life course and involves academic, social, and cultural transitions. Enrollment in higher education for these students can stimulate intense feelings/struggle between growth and loss. The youth strives to become more independent but is pulled back to traditional role assignments and responsibilities in the family. Therefore it will be important that the approach for connecting INSPIRE experiences to family recognizes and validates the delicate balance that underserved and underrepresented students often must maintain between home and school culture and community.

Accessibility to parents of underserved and underrepresented population may be challenging. Non-standard work hours and multiple employment situations can prevent parents from engaging in school or out-of-school time support activities for their children/youth. In developing the INSPIRE model, consideration should be given to what are realistic expectations for parental involvement and time commitment.

Recruitment

If the purpose of the Inspire Model is to bridge STEM experience to attract underrepresented and underserved populations, program developers may want to consider recruiting youth who do not initially show an interest in STEM in school but excel in out-of-school time programs where they are free to explore and develop their own interests and where a particular learning style might be better nurtured. Youth from underrepresented and underserved populations may not have been previously exposed to STEM in traditional classrooms in ways that they found interesting or exciting, yet given the appropriate learning stimulants and mentors could excel in STEM education. Research strongly suggests that underrepresented youth gain the most from inquiry-based science learning, and often a school's science curriculum and instruction method does not accommodate this style of learning. Looking to high school guidance staff and science educators for referrals may help bring forward otherwise overlooked INSPIRE candidates.

It may be very useful for program planners as an initial part of the recruitment stage for the Junior Explorer and Junior Guest Researcher tiers to pre-investigate at each site the potential participant pool given the student eligibility criteria. In some cases, the criteria may need to be re-evaluated in order to recruit appropriate numbers of students and those most likely to succeed in the program.

Summary

The INSPIRE program model mirrors much of the best practice about teaching and learning STEM in the out-of-school time field including program elements such as mentoring, family involvement, inquiry-based learning, and hands-on activities. In addition, NASA brings together a rich combination of exciting and inspiring resources, facilities, and people to the INSPIRE experience. To ensure the most effective program delivery, program managers will want to consider all of the research findings raised in this paper and the most helpful ways to structure teaching and learning experiences to strengthen student interest and continuation in STEM.

Appendix A

Overview of Inspire Program
INSPIRE is a multi-tiered pipeline project designed to bridge students' STEM education experiences for middle school through post-secondary students. The project framework includes three tiers of participation and activity: (1) Junior Explorers for grades 7-10; (2) Junior Guest Researchers for grades 11-12; and (3) Collegiate Interns for college freshman. A special emphasis is given to underrepresented and underserved groups to enhance STEM career opportunities.

Key Elements
Based on a review of the paper, "Overview of NASA's INSPIRE Program" we can identify the following key elements in each tier of the program.

Junior Explorers: The major element of Junior Explorers is connection to professional NASA researchers and engineers. It is intended that through organization partnerships with NASA, students will become involved in activities that promote STEM exploration and experience under the guidance, mentoring, and coaching of NASA professionals. Former participants in NASA programs such as NES and SEMMA are tapped as potential career mentors. At this participation level there also is interest in engaging participation from parents/guardians.

Junior Guest Researchers: The major element of Junior Guest Researchers 11^{th} grade is a two-week residential short course in engineering at a NASA partner college or university. Junior Guest Researchers entering 12^{th} grade participate in an inquiry-based multifaceted, six-week, mentored research experience at a NASA Center.

Collegiate Interns: The major element of Collegiate Interns is an eight-week hands-on, mentor-based work experience.

Appendix B

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Appendix C

Other Resources

1. Consumers Guide to Afterschool Science Resources is a new web-based resource created to share information collected from consumers (instructors, program leaders, parents, participants, evaluators) about sources of high-quality, hands-on science content for afterschool programs.

2. The Informal Learning and Science Afterschool research project investigates the nature of informal science in afterschool programs around the country. The three year study consists of surveys of 1,000 programs, in-depth interviews with a subset of 50, and case studies at eight sites. The study seeks to document the nature of student participation and learning in science activities in "typical" afterschool programs, and the infrastructure required to support these programs. The study is led by Gil Noam of Harvard University, Bronwyn Bevan from the Exploratorium, Rena Dorph from the Lawrence Hall of Science, and Reginald Clark. It is funded through the National Science Foundation.

(Retrieved from http://qt.exploratorium.edu/csas/activities.html)