Professional Development Increases Afterschool Staff's Confidence and Competence in Delivering Science, Engineering and Technology

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Afterschool programs are increasingly seen as a potential venue for addressing the critical need for improving science literacy among American youth. Building the capacity of afterschool staff to incorporate science, engineering, and technology youth development experiences in afterschool settings is central to this task. Few staff development training modules exist which incorporate identified best practices in nonformal science education. This study measured the effectiveness of the *4-H Tools of the Trade II…Inspiring Young Minds to Be SET Ready for Life!* staff development training manual in increasing afterschool staff's awareness, appreciation and understanding of high quality science experiences, as well as enhancing confidence and competence in delivering in afterschool environments.

There is no time in history when it has been more important for us to prepare young people to be proficient in science, technology, engineering, and math (STEM). "For the first time in generations, the nation's children could face poorer prospects than their parents and grandparents did" is the startling prediction of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2007, p. 13). In their report, *Rising Above the Gathering Storm*, a major premise is the poor performance of American children in science, technology, engineering and math (STEM), a lower number of students pursuing advanced degrees in these same disciplines, and declining teacher preparation to teach these subjects.

Increasingly afterschool programs are considered a potential venue for sparking youths' interest and enhancing their skills in STEM topics, as well as reinforcing formal classroom learning in these subjects. The National Research Council's report, *Surrounded by Science: Learning Science in Informal Environments* (Bell, Lowenstein, Shouse & Feder, 2009), emphasizes that "despite the widespread belief that schools are responsible for addressing the scientific knowledge needs of society, the reality is that schools cannot act alone (p. 1)." The Council's lengthy report highlights the role and value of informal experiences as provided by afterschool programs, to improve science education and learning.

According to the Coalition for Science Afterschool (CSAS) in *Science in Afterschool: A Blueprint for Action* (Friedman & Quinn, 2007), afterschool programs have characteristics that make them uniquely suited to provide science-rich experiences. Afterschool programs allow young people to explore their own interests, at their own pace (Miller, 2003), form their own questions for further exploration (Friedman & Quinn, 2007), practice knowledge gained in school (McLaughlin, 2002; Miller, 2003), and provide authentic hands on opportunities for skill building (Noam, Biancarosa & Dechausay, 2003). Furthermore, seventy-five percent of Nobel science winners attribute that their interest in science was first cultivated outside the classroom (Friedman, 2005).

Critical to the effective delivery of STEM in afterschool settings is well trained staff. The Coalition for Science Afterschool (2007) accentuate that the goals of increasing the quality of science programming in afterschool cannot be achieved without investment in building afterschool staff capacity in these areas. This is echoed by Freeman,

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Dorph, and Chi (2009) whose work indicates "transforming the existing cadre of afterschool instructors into effective facilitators of STEM learning will require significant attention to and investments in staff development." In their CSAS sponsored report, *Strengthening Afterschool STEM Staff Development* (2009, p. 24), they draw on the work of Gil Noam (2008) in *A New Day for Youth*, who describes quality afterschool programming as having three essential elements; staff capacity, including training, and relational care being one of three sides of his triangular model (programmatic support and content are the other two sides).

This need is demonstrated in the *Science in Afterschool Market Research Study* (Chi, Freeman & Lee, 2008). The study indicates that approximately 76% of afterschool programs do not have a dedicated science person on staff and most who teach science have little science background. Even more notable in the study, is that approximately half of the staff who lead science activities in afterschool programs have not participated in STEM staff development opportunities.

The field has begun to identify three broad staff populations with unique views and needs requiring targeted approaches to meet their STEM staff development needs (Freeman, Dorph & Chi, 2009). These can be described as afterschool staff who are:

- Receptive to STEM but lack understanding of the need and how to address it. This group benefits from training emphasizing the positive impact of STEM and use of high quality curriculum resources and best practices.
- Resistant to STEM because of a perceived lack of experience. Staff development for this group should focus on STEM processes and student-centered activities that require less content expertise.
- Demanding fun activities at the expense of consistent programming and defined learning objectives. These staff benefit from resources that are effective and easy to install and training that values consistency, sequential learning and relevance to the school day.

Attitudes of afterschool staff towards STEM have been identified in other studies as a barrier to delivery of effective programs. Seidel, Aryeh, & Steinberg (2002, p. 34) found that excellence in science delivery was associated more with beliefs and attitudes than with particular training or skills. The CSAS Staff Development Community of Practice (Freeman, Dorph & Chi, 2009) identified staff's fear of science, viewing science as an academic subject only, and a preference for playing with kids rather than teaching them as issues influencing staff development. The National Research Council (1998) in *Every Child a Scientist*, highlights the importance of teacher interest and motivation in science learning as does Dierking (2007) in her work.

Afterschool staff also often have uneven backgrounds in respect to science content and pedagogy and may lack strong facilitation skills needed to deliver effective STEM activities (Walker, Wahl & Rivas, 2005). However, studies show afterschool staff, as facilitators, can help develop and deepen youth's interest for science (Hidi & Renninger, 2006), an important first step in science learning (Renninger, 2007). Mentors and staff who receive facilitation training have been shown to be more successful in providing educational experiences in afterschool programs (Ferreria, 2001; Foster, 2001; Jekielek, Moore & Hair, 2002).

Afterschool staff report they would like to increase the quantity and quality of science activities provided in their afterschool settings (Chi, Freeman & Lee, 2008). *The Science in Afterschool Market Research Study* (Chi, et al., 2008) asked staff what types of support would be needed to increase quality and/or quantity of science activities for afterschool youth. Staff identified significant challenges including limited funding, time, staff training and staff interest for science programming.

The near absence of significant empirical research in effective afterschool staff development in STEM presents challenges for designers of effective training curriculum. Schwartz and Noam (2007) suggest looking at best practices in quality afterschool programming for direction in designing staff development programs. Using the knowledge and understanding of the previously discussed issues

surrounding professional development of afterschool program staff, we, along with colleagues, Jackie Reilly and Eric Killian at the University of Nevada, Reno, developed a comprehensive staff development training guide, *Tools of the Trade II…Inspiring Young Minds to Be SET Ready for Life!* (Junge, Manglallan, Reilly, & Killian, 2009).

This report presents an evaluation of the effectiveness of an eight hour training, utilizing the *Tools of the Trade II ... Inspiring Young Minds to Be SET Ready for Life!*, a guide for increasing afterschool and out-of-school time (OST) staff's understanding, knowledge and confidence in delivering science, engineering, and technology (SET) content trainings and providing quality SET experiences with youth.

Description of *Tools of the Trade II …SET Ready for Life!*

Drawing from research and best practices, *Tools of the Trade II ...Inspiring Young Minds to Be SET Ready for Life!* uses a hands-on, experiential, interactive skill-building approach to enhance the capacity of afterschool staff to incorporate effective science, engineering, and technology youth development experiences in afterschool settings. Specifically, the training curriculum is designed to:

- Increase awareness, appreciation, and understanding of youth science, engineering, and technology programming in afterschool settings.
- Increase knowledge, skills, competence, and confidence in identifying, designing, and delivering high quality science, engineering, and technology experiences that are age-appropriate and based on best practices.
- Increase afterschool staff ability to develop effective partnerships and collaborations to support science, engineering, and technology.

Content for the curriculum intentionally focuses on utilizing inquiry-based and experiential learning strategies, incorporating science, engineering and technology processes, creating SET-rich environments, embracing the role as a facilitator of quality science learning, increasing confidence in delivering SET, and incorporating SET abilities in afterschool programs. Following is a discussion of each.

Utilizing Inquiry-based and Experiential Learning Strategies

An abundance of research points to the critical importance of facilitators of STEM learning to utilize inquiry-based and experiential learning strategies in their teaching (Feichel, & Schweingruber, 2010; Bell, Lewenstein, Shouse, & Feder, 2009; National Research Council, 2000). Inquiry strategies capitalize on youths' curiosity and the scientific method to support youths' learning of critical thinking skills, as well as important science content and concepts (National Research Council, 1996). It is important to complement inquiry-based learning with the use of experiential learning (STEL Workgroup, 2005). Experiential learning focuses on the *process of learning*, rather than the *product of learning,* and is especially effective when the goal of the learning is *understanding in depth* verses just information transfer (STEL Workgroup, 2005). As accentuated in the training, afterschool staff need to be mindful that all hands-on learning does not necessarily include experiential or inquiry learning and they should be thoughtful and intentional in incorporating these and questioning strategies in their science facilitation.

Incorporating Science, Engineering and Technology Processes

The *process skills* of science, engineering, and technology are integrated into the abilities of scientific inquiry (National Research Council, 2000) and emphasize asking questions, planning and conducting investigations, using appropriate tools and techniques to collect data, thinking about the relationship between evidence and explanations, constructing and analyzing explanations and communicating the results. Early in the formative development of the *Tools of the Trade II…Inspiring Young Minds to be SET Ready for Life!* manual, when working with afterschool directors and line staff, we surprisingly observed that many did not have a working definition of science, engineering and technology and were not able to readily differentiate between the three disciplines, nor see the inter-connection of the three. This led us to design *Explore It! Design It! Use It!*,

the first content session of the manual, to establish a baseline of understanding and anchor future teaching.

Creating SET Rich Environments

The National Research Council's report, *Learning Science in Informal Environments…People, Places and Pursuits* (Bell et al., 2009), outlined six strands that informal educational programs should strive for when designing science learning experiences in informal settings like afterschool programs. These six strands include an opportunity for youth to: develop an excitement and joy for science; use and understand concepts and facts; test, explore, question, observe and make sense of the natural and physical world; understand science processes; use science language and tools; and see themselves as science learners and someone who knows about, uses and sometimes contributes to science.

For this reason, a session was developed specifically to teach these six aspects of quality informal science education. The effectiveness of this session in increasing participants' knowledge and understanding of how to apply these elements is important evidence to improving SET learning environments in afterschool programs.

Embracing Role as Facilitator of Quality Science Learning

Introducing youth to the culture of science, including its reasoning, tools of observation and measurement, standards of evidence, and the values and beliefs underlying scientific knowledge, is a "major instructional challenge" (National Research Council, 2005, p. 421). The role of the facilitator or teacher is critical. Even facilitators who are not experts in science can be effective intermediaries to informal learning (Feichel & Schweingruber, 2010, p. 77). The facilitator can create an environment where STEM learning is valued and supported, help spark the youth's interest, guide the investigation and discovery, and scaffold the learning. Staff's understanding of participant interest have shown to influence the organization, facilitation and youth participation in science activities (Renninger, 2007).

Increasing Confidence in Delivering SET

As discussed earlier, afterschool staff's fear of science, viewing science as an academic subject only, and a preference for playing with kids rather than teaching them (Freeman, et al., 2009) all contribute to a lack of confidence in delivering science. Addressing these issues with staff, as is done in the first session of the *Tools of the Trade II…Inspiring Young Minds to Be SET Ready for Life!* training, is a first step in building confidence. Providing ongoing support and encouragement, intertwined within the session content is essential. Helping staff to view themselves as learners, being eager to try new ways of teaching and extend and sharpen their subject matter knowledge is recommended by the National Research Council (2000).

Incorporating SET Abilities in Afterschool Programs

The science education field continues to grow in its understanding of how youth learn science and how it should be taught. The National Research Council (1996) recommends a shift in practice, from being solely focused on the content to be learned, to one of how to learn the content and how the content is taught. The integration of SET abilities instruction into everyday afterschool programming supports this recommendation.

See Figure 1 for descriptions of the 14 workshops, encompassing 21 hours of training, which incorporate the above-referenced elements identified as being important to the professional development of afterschool staff delivering science programming.

METHOD

Sample

This study was conducted using a multi-site evaluation methodology, with each of five training locations (Davis, Los Angeles, Merced, Watsonville, and San Diego) using the same questionnaire and following the same protocol. Participants represented a diverse cross-section of afterschool programs from urban, suburban and rural areas, funded through a

FIGURE 1
Tools of the Trade II Session Description

Tools of the Trade II

Inspiring Young Minds to be SET* Ready for Life!
*Science, Engineering, & Technology

SESSION DESCRIPTIONS

Session I: Inspiring Young Minds…The Scientist in All of Us
Science is everywhere! Kids are curious and love to learn about the world around them. Afterschool staff can play an important role in facilitating youth's learning about science, engineering, and technology (SET). This session provides an introduction to the Afterschool SET Ready for Life Checklist and elements for high quality SET programming in afterschools.

Session 2: Explore It! (Science) Design it! (Engineering) Use it! (Technology)
What does it mean to be scientifically literate? The American Association for the Advancement of Science describes a scientifically literate person as one who is aware that science, engineering, and technology are human enterprises and applies scientific content and abilities in meaningful ways. Understanding the relevance of science, engineering, and technology and the language of math in afterschool settings and how these complement each other is the focus of this session.

Session 3: SET Abilities for the 21st Century!
Hearing a lot about science, engineering, and technology (SET) these days? In a fun and hands-on way, learn which SET abilities 21st century kids need for success and how your program can support the development of these skills and abilities in fun and interactive ways. Special emphasis is given to fostering observation skills, one of the most critical SET abilities.

Session 4: Hands On! Minds On!...Inquiry and Experiential Learning
Inquiry and experiential learning are natural ways to learn. This session introduces youth workers to the concepts of experiential learning and science inquiry. Understanding these concepts helps youth workers capitalize on kid's interests, assure better learning outcomes and provide exciting learning opportunities for acquisition of science, engineering, and technology knowledge and skills.

Session 5: How Kids Learn Science and What Does It Mean to Afterschool
Thanks to science research and more sophisticated engineered technologies, such as PET scans, we know much more about how kids learn and how educators can facilitate enhanced learning. This session will focus on three fundamental principles for learning as identified by the National Academics of Science: 1) attention to prior knowledge; 2) foundation of factual knowledge and understanding; and 3) learner self-regulation. This session builds on Session 4 which introduces inquiry and experiential learning as important strategies for effective learning.

Session 6: Kid Fit Science…Ages and Stages and SET
Afterschool programs often serve youth ages 5 to 14. Recognizing the different ages and stages of youth and applying this to science, engineering, and technology (SET) programming is critical to achieving desired youth outcomes. In this session, afterschool staff will review developmental stages of afterschool youth and learn how to facilitate SET with mixed-age groups. Applying the National Science Education Content Standards to age-appropriate practice is also covered.

Session 7: Creating SET-Rich Environments
Science is everywhere! Afterschool staff play an important role in developing SET learning opportunities, increasing youth's natural interest, promoting learner-centered science and integrating science throughout the afterschool hours. Science is not just topic to study, it is a way of thinking that can be applied to many components in the afterschool setting. This session uses a carousel of group-directed, mini-centers that feature ways to create SET-rich environments.

Session 8: Under the Microscope…How to Identify and Adapt SET Curriculum for Afterschool
Afterschool staff may be uncertain of how to select a science, engineering, or technology (SET) curriculum that meets the needs, interests, and ages of kids in their program. This session focuses on how to use a rubric for assessing quality SET curriculum and activities that will inspire kids to want to learn more!

Session 9: SET Everyday…Using Centers in Afterschool
This session focuses on knowledge-centered, learner-driven activities that can be easily delivered through centers in your afterschool program. Eleven elements of effective SET (science, engineering, and technology) learning centers are discussed. Tips for facilitating and managing centers are also covered.

Session 10: Science and Literacy…Using Fiction and Non-Fiction Science Text in Afterschool
Books are an important element of science learning. This session focuses on how to select and incorporate a variety of science, engineering, and technology (SET) genre in afterschool programs to support children's exploration and learning.

Session 11: Teens in Afterschool...What's the SET Connection?
Teens can be engaged in afterschool in many ways. They can be mentors and effectively involve younger youth in science, engineering, and technology programming. This session will look at youth-adult partnerships and how these partnerships can enhance the experience for younger youth and teens.

Session 12: Building the Bridge…Using Collaboration and Partnerships to Strengthen Your SET Programming
Creative partnerships have transformed afterschool programs and inspired kids' interest in science, engineering, and technology (SET) while supporting positive youth development. Providing SET experiences in your afterschool programs is hard to do alone. Qualified and willing community partners and collaborators can strengthen your program and add more interest.

Session 13: Family Science …It's Not How I Learned Science!
Involving parents and families in afterschool science, engineering, and technology (SET) programming produces real payoffs for youth, families, and afterschool programs. Afterschool staff have a powerful influence on sparking families' interest in SET. Learn how to extend youth's learning and increase their interest in SET through family science nights, family take-home backpacks, and other strategies that involve parents in your afterschool program.

Session 14: Ready SET Go! SET in Afterschool
How do we use all that we know about science, engineering, and technology and learning in an afterschool program? This session includes a review of the Afterschool SET Ready for Life Checklist and how to use it in your afterschool program. Additionally, the session helps participants create an action plan for implementing the concepts presented in Tools of the Trade II: Inspiring Young Minds to be SET* Ready for Life (*Science, Engineering, and Technology.)

variety of funding streams including state and federal afterschool programs, military child care, private, and nonprofit programs. Seventy-seven participants completed the questionnaires at the end of an eight hour full day training.

Data

Seven retrospective pre/post questions related to the afterschool staff's perceived understanding of SET concepts and their confidence and readiness in delivering high quality science experiences, while narrative questions allowed participants to express those aspects of the training which were most valuable to their learning. The items were drawn from the session evaluations developed to measure outcomes for each workshop contained in the *Tools of the Trade II…Inspiring Young Minds to be SET-Ready for Life!* staff development guide. These included elements of high quality SET programming, inquiry and experiential learning, SET processes, and SET-rich environments, as well as their facilitation skills, confidence, and ability to incorporate these into an afterschool setting. See Table 1 for specific questions. Participants rated each item as to how they felt before and after the training, using the retrospective pre-test and a Likert-type scale where 1= *not at all*, 2=*slightly*, 3=*somewhat*, 4=*very* and 5=*absolutely*.

The retrospective pretest-postest approach was deemed appropriate, as some of the participants could possibly overestimate their knowledge and understanding of the SET concepts before the training (Pratt, McGuigan, & Katzev, 2000). Rockwell and Kohn (1989) report the retrospective design has shown to provide greater accuracy of response in situations where participants are asked to respond to a question about how much they know about a particular subject after they have some knowledge of the subject. In these cases, using the retrospective format, the participant is able to more accurately reflect on the degree of change in knowledge or attitude. Additionally, the retrospective design, having only to be administered once during the training, was more time efficient and less obtrusive to the participants (Hill & Betz, 2005).

The eight hour training included five of the fourteen workshops included in the *Tools of the Trade II ... Inspiring Young Minds to Be SET Ready for Life!* professional development guide. Content included: science, engineering, and technology processes, inquiry and experiential learning, SET-abilities, SET-rich environments, using fiction and non-fiction SET text, and introduction to SET in afterschool. Participants were also asked to list the three most important things learned that they would use in their program.

Analysis

Participants' before and after ratings were analyzed using a paired *t* test. Qualitative ratings were analyzed through frequency counts of responses subsequently which were ranked to reveal the top three most important things learned that participants would use in their program.

RESULTS

Analysis revealed a significant, positive change for each of the seven items ($p < .0001$). Differences in means between the pre- and post- survey responses ranged from 1.30 for *understand and know how to use science, engineering and technology processes* to 1.99 for *understand how to create SET-rich environments that incorporate the six strands outlined by the National Research Council*. Table 1 presents the retrospective pre-test – post-test training mean scores and results of the paired *t* tests.

Participants were asked to list *the three most important things learned that you will use in your program.* The most frequently cited responses included the following.

Inquiry, experiential, and hands-on strategies

These concepts were emphasized throughout the eight hour training and specifically targeted in the session, *Hands-On! Minds-On! Inquiry and Experiential Learning*. Participants provided comments such as "Children learn and remember when they have hands-

TABLE 1
Knowledge and Understanding Before and After Training

	N	Before Training	After Training	Mean Difference*	*p*-value
1. Understand the elements of high quality SET programming in afterschool programs.	73	2.27*	4.19	1.92	< .0001
2. Understand inquiry and experiential learning and how to apply to SET programming in afterschool settings.	73	2.49	4.24	1.75	< .0001
3. Understand and know how to use science, engineering and technology processes.	73	2.9	4.2	1.30	< .0001
4. Understand how to create SET-rich environments that incorporate the Six Strands (NRC).	61	2.01	4.0	1.99	< .0001
5. Recognize and appreciate afterschool staff's role as a facilitator of youth's acquisition of SET.	72	2.9	4.37	1.47	< .0001
6. Feel confident to train afterschool staff to deliver high quality SET programs.	60	2.5	4.15	1.65	< .0001
7. Understand the concept and content of SET abilities and how to incorporate in an afterschool setting.	72	2.55	4.16	1.61	< .0001

*Means are based on a Likert scale of 1-5 with 1 meaning *not at all* and 5 meaning *absolutely.*

on inquiry," "Difference between hands-on learning and inquiry-based," "The difference of real hands-on and textbook hands-on," "Using open-ended projects allow more creativity," and "Experiential learning is much more fun and effective than traditional learning."

Question Strategies and Incorporating Science Language

Questioning strategies is an essential part of inquiry and was heavily modeled throughout the entire training. It also was the strategy most often listed as one participants plan to apply. Specifically mentioned were: "How to ask questions," "How important open-ended questions are," "Allowing youth time to think about questions," "Question style," and "Incorporate science language and questioning into training."

Science, Engineering, and Technology Processes

Participants repeatedly mentioned their intention to emphasize more of the science processes in their programming. Specifically mentioned were: "What the science processes are," "How science is in engineering and technology," "What is a scientist, engineer, and technologist," and "How to use the processes in presenting SET."

SET Abilities

The National 4-H SET initiative introduced the concept of *SET Abilities* (Horton, Gogolski, & Warkentien, 2007), which are the thirty abilities most frequently cited in STEM education literature as being essential for youth science literacy. An entire session of the workshop was devoted to SET Abilities, with a specific focus on honing youths' observation skills. Comments made by participants included: "Do skill activity w/teens and afterschool staff to help them understand observation," "Observations," "SET abilities to be ready for life," and "How to use SET abilities to teach children to be successful."

DISCUSSION AND CONCLUSION

The results of the evaluation revealed the training led to positive change in participants' knowledge of core aspects of quality SET programming in afterschool settings, understanding their important role as a facilitator of effective science, engineering, and technology and their confidence and ability to apply the principles of the training. The study also provides more evidence on the effectiveness of using a comprehensive training manual, designed specifically for afterschool programs and based on research and

best practice, to enhance afterschool staff and trainers' skills, competence, and confidence in improving the quality of afterschool STEM programming. The training, anchored in positive youth development practices, focused on building internal program expertise while meeting professional development needs; both are recommendations of CSAS's *Strengthening Afterschool STEM Staff Development* report (Freeman et al., 2009).

We recognize the limitations in the study. Although the participants in the study represented diverse (geographic, socio-economic, philosophies, and funding streams) afterschool programs, it was not a random sample, but rather those who attended one of the scheduled trainings. Additionally, a study focusing on the effectiveness of those who received the training in delivering the content to other afterschool staff would be valuable. Finally, although the retrospective pretest - posttest was deemed appropriate for the situation and the changes being measured, the findings must be tempered by the bias that could be present in participants' responses (Hill & Betz, 2005).

Although this study is an important first step is measuring benefits of professional development in enhancing program quality, there is a need for more comprehensive evaluations that assess the long-term outcomes including enhanced youth performance (Bouffard & Little, 2004).

REFERENCES

Bell, P., Lewenstein, B., Shouse, A., & Feder, M.A. (Eds.) (2009). *Learning science in informal environments: People, places and pursuits*. Committee on Learning Science in Informal Environments. National Research Council. Board of Science Education. Division of Behavior and Social Science and Education. Washington, DC: National Academies Press.

Bouffard, S., & Little, P.M.D. (2004). *Promoting quality through professional development: A framework for evaluation* (*Issues and Opportunities in Out-of-School Time Evaluation Brief No. 8*). Cambridge, MA: Harvard Family Research Project.

Chi, B.S., Freeman, J., & Lee S. (2008). *Science in afterschool market research study*. A study commission by the S.D. Bechtel, Jr. Foundation. Berkeley, CA: Lawrence Hall of Science, University of California, Berkeley.

Dierking, L.D. (2007). *Linking afterschool programs and STEM learning: A view from another window*. Newton, MA: ITEST Learning Resource Center.

Ferreria, M. (2001). *The effects of an afterschool program on middle school female students' attitudes towards science, mathematics, and engineering*. Proceedings of the Annual Meeting of the Association for the Education of Teachers of Science.

Feichel, M., & Schweingruber, H.A. (2010). *Surrounded by science: Learning science in informal environments*. Board of Science Education, Center of Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Foster, L. (2001). *Effectiveness of mentor programs: Review of the literature from 1995-2000*. Sacramento, CA: California Research Bureau.

Freeman, J., Dorph, R., & Chi, B. (2009). *Strengthening afterschool STEM staff development*. Berkeley, CA: Lawrence Hall of Science, University of California, Berkeley.

Friedman, L. (June 2005). *Where is afterschool headed and how do science learning opportunities fit into the afterschool landscape*. New York: The Afterschool Corporation.

Friedman, L., & Quinn, J. (2007). *Science in afterschool: A blueprint for action*. Coalition for Science Afterschool. New York: The Afterschool Corporation.

Hidi, S., & Renninger, K.A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111-127.

Hill, L.G., & Betz, D.L. (2005). Revisiting the retrospective pretest. *American Journal of Evaluation, 26*(4), 501-517.

Horton, R.L., Gogolski, J., & Warkentien, C. (2007). *Science, engineering, and technology (SET) programming in the context of 4-H youth development*. Chevy Chase, MD: National 4-H Council.

Jekielek, S., Moore, K., & Hair, E. (2002). *Mentoring: A promising strategy for youth development.* (*Child Trends Research Brief*). Washington, DC: Child Trends.

Junge, S.K., Manglallan, S., Reilly, J., & Killian, E. (2010). *Tools of the Trade II: Inspiring young minds to be SET ready for life!* University of California. Davis, CA: Division of Agriculture and Natural Resources.

McLaughlin, M.W. (2002). *Community counts: How youth organizations matter for youth development.* Public Education Network Monograph. New York: The Robert Bowne Foundation.

Miller, B. (May 2003). *Critical hours: Afterschool programs and educational success*. Quincy, MA: Nellie Mae Education Foundation.

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: National Academies Press.

National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academies Press.

National Research Council. (1998). *Every child a scientist: Achieving scientific literacy for all.* Washington, DC: National Academies Press.

National Research Council. (2000). *Inquiry and the national*

science education standards: A guide for teaching and learning. Washington, DC: National Academies Press.

National Research Council. (2005). *How students learn: Science in the classroom.* M.S. Donovan and J.D. Bransford (Eds.), Washington, DC: National Academies Press.

Noam, G., Biancarosa, G., & Dechausay, N. (2003). *Afterschool education: Approaches to an emerging field.* Boston, MA: Harvard Education Press.

Noam, G. (2008). *A new day for youth: Creating sustainable quality in out-of-school time.* A White Paper commissioned by the Wallace Foundation. Cambridge, MA: Harvard University.

Pratt, C.C., McGuigan, W.M., & Katzev, A.R. (2000). Measuring program outcomes: Using retrospective pretest methodology. *American Journal of Evaluation, 21*(3), 341-349.

Renninger, K.A. (2007). Interest and motivation in informal science learning. Unpublished report. Retrieved March 2010, from http://www7.nationalacademies.org/bose/Renninger_Commissioned_Paper.pdf

Rockwell, S.K., & Kohn, H. (1989). Post-then-pre evaluation. *Journal of Extension* [On-line] *27*(2). Available at http://www.joe.org/joe/1989summer/a5.html

Schwartz, S.E., & Noam, G.G. (2007). *Informal science learning in afterschool settings: A natural fit?* Boston, MA: University of Massachusetts.

Seidel, S., Aryeh, L., & Steinberg, A. (2002). *Project-based and experiential learning in afterschool programming.* Project Zero, Harvard Graduate School of Education.

STEL Workgroup. (2005). *Experiential Learning Workshop.* Retrieved March 15, 2009, from http://www.experientiallearning.ucdavis.edu

Walker, G., Wahl, E., & Rivas, L., (2005). *NASA and afterschool programs: Connecting to the future.* NASA Grant by American Museum of Natural History, New York.