Harvard Family Research Project

Research Update

HIGHLIGHTS FROM THE OUT-OF-SCHOOL TIME DATABASE

NUMBER 5 JANUARY 2011

STEM Out-of-School Time Programs for Girls

ABOUT THE OST DATABASE & BIBLIOGRAPHY

Our online Out-of-School Time Program Research and Evaluation Database (OST Database) includes profiles of evaluations and research studies about OST programs and initiatives. Our OST Bibliography contains citations for all of the OST program evaluations and research studies that we are currently tracking. These valuable and easy-to-use resources can help you learn about and improve OST research and evaluation. They can also support policy and program development.

Visit the database and bibliography on our website at *www.hfrp.org/OSTDatabase*.

The publications in this series each focus on a particular theme of interest to the out-of-school time field, related to the evaluations and research studies that are available in our Out-of-School Time Program Research and Evaluation Database and Bibliography.

Increasing knowledge of and engagement with science, technology, engineering, and mathematics (STEM) has recently been brought to the forefront of education reform in the United States in an effort to prepare students for the challenges of the twenty-first century global economy.[1] Out-of-school time (OST) programs that focus on girls' involvement in STEM can play an essential role in improving female representation in these traditionally male-dominated fields. OST programs offer girls a non-threatening and non-academic environment for hands-on learning that is collaborative, informal, and personal. However, barriers to quality implementation and outcome-based evaluation present challenges for STEM programs serving girls. This *Research Update* highlights findings from the evaluations and research studies in the OST Database that focus on STEM programs for girls.

Overview of the Programs and Studies Featured

The six STEM programs covered in this *Research Update* reflect the diversity of approaches to STEM education, including structured afterschool modules, recreational activities, intensive summer trips, and mentoring. These programs mainly serve youth in middle school and high school, with some targeting girls only, and others available to both boys and girls but with a particular focus on girls. Of these six programs, five had evaluations that used a non-experimental design, and one had a quasi-experimental design (Girls Creating Games). Full citations for the evaluation reports are included in the Appendix at the end of the report. Table 1 (next page) provides an overview of these six programs and their evaluations.

The remainder of this brief addresses the benefits, challenges, and successful strategies of STEM OST programs aimed specifically at girls, based on data from evaluations of these six programs.

TABLE 1. STEM Programs Profiled in the OST Research and Evaluation Database

Program	*Youth Activities Offered*	*Population Served*	*Evaluation Purpose*
Girls Creating Games	Afterschool and summer curricula for creating computer games	Middle school girls in Capitola, California	To address whether participants increased their capacity to pursue and persist with computer technology, and how the program could be improved
Girls Incorporated—Thinking SMART Program	Afterschool curriculum modules for engineering, ecology, space/physics, and computer science	Middle school through high school girls, nationally	To examine changes in participants' STEM interest, knowledge, confidence, and attitudes
Mixing in Math	Afterschool math-based group activities, web-based resource materials, technical assistance, and curriculum dissemination efforts	Kindergarten through middle school youth nationally, with several sites focused exclusively on girls	To explore how participating afterschool programs implemented the Mixing in Math curriculum, the changes in informal math education at pilot sites, and what factors influenced quality implementation
Project Exploration	Summer paleontology field expeditions, mentoring and leadership development opportunities, service learning programs, and hands-on science afterschool and weekend programs	Middle school through high school youth in Chicago, Illinois, with one program site exclusively for girls	To examine program purpose and design, strategic planning, program management, and program results and accountability
SECME RISE (Raising Interest in Science & Engineering)	Summer Leadership Academies, which provide team-based engineering design challenges, technology training, field trips, and interactions with minority female engineers	Middle school girls in Miami-Dade County, Florida	To describe project implementation and provide information on short-term outcomes
STUDIO 3D (Digital, Design, and Development)	Afterschool and summer computer technology projects	Elementary through high school youth (aged 10–18 years) in Minneapolis and St. Paul, Minnesota	To assess the program's impact on student learning and provide information for program improvement

How Girls Benefit from STEM OST Programs

STEM OST programs demonstrate a number of positive outcomes for girls (and in some instances, boys) related to academic achievement and school functioning, youth development, and workforce development. Table 2 (next page) summarizes some of the major benefits to girls reported in the evaluations of STEM programs in the OST database. In some cases, the data suggest neutral outcomes. Only one evaluation included findings that could be interpreted as negative: Specifically, the Thinking SMART evaluation found slight pretest to posttest declines in girls' interest in specific STEM careers, and increases in agreement with certain negative gender stereotypes about STEM.[2] However, for the most part, the data suggest positive outcomes for program participants.

The STEM programs for girls profiled in the OST database typically contained evaluation findings related to academic/school outcomes. The most common outcomes included increased confidence in their math skills, improved attitudes toward and engagement in math, and increased plans to attend or enroll in college. There was little overlap across programs for the remaining outcome categories, with youth development improvements in girls' views of gender stereotypes representing the only other finding shared by multiple programs. The wide variety of findings across programs highlights the diversity of STEM education approaches and outcomes in OST settings.

Table 2: Benefits of STEM OST Programming for Girls

Type of Outcomes	*Types of Youth Outcomes Reported*
Academic Achievement and School Functioning	*Increased or improved:* • Confidence using math skills • Attitudes towards and engagement in math • Plans to attend or enroll in college • Attitudes toward school • English language skills for English-as-a-second language students • Connections of math concepts to everyday life • Classroom behavior • High school graduation rate • Number of female science majors in college
Youth Development	*Increased or improved:* • Problem-solving skills • Social supports • Perceptions about computer knowledge • Computer skills • Confidence using computers • Attitudes toward STEM media messages • Comfort-level with technology *Fewer:* • Gender stereotypes
Workforce Development	*Increased or improved:* • Knowledge about STEM careers • Interest in STEM careers

Challenges Faced by STEM Programs for Girls

STEM OST programs for girls face challenges that are unique to the nature of their program settings, the distinct subject matter they promote, and the specific population they focus on serving. In particular, these programs are tackling an issue which schools often struggle to address: how to increase girls' interest and engagement in STEM, a traditionally male-dominated realm. The major challenges faced by STEM OST programs for girls are addressed below.

There is a limited body of existing research on OST programs focused on STEM education, and therefore there is a lack of consensus on metrics. Measurable impacts of STEM programs for girls tend to be scarce in the OST field—compared to in-school curricula, relatively little is known about best practices, implementation, cost-effectiveness, and impact of STEM OST programs in general, let alone those that target girls specifically. As a result, many STEM OST programs for girls are in the early stages of developing quality evaluation efforts as outcome-driven data become increasingly more important in the field. The nascent stage of this work presents an ongoing challenge to incorporate more rigorous (i.e., experimental) evaluation designs into the culture of STEM OST organizations serving girls.

While some OST programs focus solely on STEM education, in other programs STEM must compete for time and resources with many different curricular components. These resources may include planning and implementation time, professional development for staff, and program oversight from organizational leadership. For staff at non-specialized OST programs, implementing STEM curriculum is just one of many demands, and this added responsibility may cause stress in the absence of sufficient training on STEM materials. OST program staff who lack a background in STEM or experience presenting educational content may feel especially overwhelmed without proper preparation or support.

STEM OST programs require ongoing technical training in the subject matter. Personnel for STEM programs require not only skills and experience in youth development, but also technical skills and expertise related to the STEM content. In addition, STEM curricula are unique to each program and organizations must provide frequent and up-to-date training for new staff members since programs often have a high staff turnover. It can also be difficult for OST programs to maintain staff accountability for quality implementation as experienced staff leave and newer staff step into their roles.

STEM OST programs struggle to engage girls who do not initially express interest in STEM subject matter. Youth who already have a particular interest in STEM tend to gravitate toward and remain engaged in STEM OST programs. This self-selecting participation process is especially marked among girls, who are among a small pool of participants with a specialized interest in such OST programs. However, predisposed participants have limited room for improvement in STEM interest levels and exposure, so programs struggle with outreach strategies to attract participants who would not otherwise be interested in STEM. Programs also face the challenge of retaining those participants who feel bored and do not connect with the STEM materials once they have started the program.

Successful Strategies for STEM Programs for Girls

The following strategies from evaluations of STEM programs emerged as particularly successful for this type of programming:

Establish measurable goals specific to the STEM objectives. It is important to articulate goals that are clear, achievable, aligned with the STEM programming, and have specific progress indicators. In particular, program goals should

- Translate into measurable objectives related to STEM
- Use outcome-based guidelines to obtain baseline data in order to establish targets
- Be tied to a long-term evaluation plan (as seen in the Project Exploration [PE] evaluation[3])

Appoint a leader to oversee STEM programming. Having someone to champion STEM education from within the program can be a major determining factor in whether it is valued or neglected, especially when programs include a variety of non-STEM components. A person with responsibility for and oversight of STEM programming can influence how time, resources, and personnel are appropriated, giving staff the necessary support to implement curriculum effectively. For example, the Mixing in Math (MiM) evaluation found higher levels of quality implementation at OST sites with active involvement of program directors and lead teachers.[4] The MiM evaluation also reported that, from the OST staff perspective, having a leader to advocate for STEM curriculum was a major factor in encouraging its continued use.

Customize STEM experiences for a specific demographic of the target population. OST programs may be better able to engage girls when they try to relate STEM activities to the girls' lives in terms of their age, interest in particular STEM subjects, preferred mode of learning (e.g., discussion or hands-on learning), and ability level. Tailoring this experience can be especially helpful in engaging girls who otherwise might not be inclined to engage with STEM subject matter.

Build personal connections with girls to help sustain their engagement. Once girls join a STEM OST program, the goal then becomes to maintain their interest over time, which can be facilitated through staff's efforts to build strong relationships with the girls. For example, PE has had success using a relational approach, in which PE places learning in the context of interactions and relatable experiences.[5] The PE evaluation shows this approach contributing to the program's success in both retaining participants from one year to next and staying in contact with alumni throughout high school. In another example, the MiM evaluation indicates that participants became bored when they were not connecting with STEM material.[6]

Make STEM activities accessible to all, to prevent against a self-selecting process. OST programs should have an inclusive approach to ensure that girls feel welcomed and comfortable with the materials. Both boys and girls may see STEM activities as overly technical and intimidating, but girls often do not receive the same encouragement that boys do to get involved (or may need some extra encouragement). As part of this inclusive approach, programs can increase outreach efforts through such means as partnering with schools to disseminate information and gauge interest from school-wide populations instead of just self-referred youth.

Katie Chun, Research Assistant
Erin Harris, Project Manager
Harvard Family Research Project

Acknowledgments

Preparation of this *Research Update* was made possible through the support of the Charles Stewart Mott Foundation.

Notes

1 President's Council of Advisors on Science and Technology. (2010). *Report to the President: Prepare and Inspire: K–12 education in science, technology, engineering, and math (STEM) for America's future (Prepublication version).* Washington, DC: Author. Online at: http://hub.mspnet.org/index.cfm/21031

2 Bruschi, B. (2008). *Final summative evaluation report: Girls Inc. Thinking SMART Program*. Indianapolis, IN: Girls Incorporated National Resource Center. The OST database profile of this program can be found online at: www.hfrp.org/GirlsInc-ThinkingSmart.

3 Project Exploration. (2006). *Project Exploration: Youth programs evaluation*. Chicago: Author. Online at: www.projectexploration.org/PDF/program-eval-v2-final.pdf. The OST database profile of this program can be found online at: www.hfrp.org/ProjectExploration.

4 Miller, B. (2009). *Mixing in Math evaluation final report*. Brookline, MA: Miller Midzik Research Associates. Online at: www.informalscience.org/reports/0000/0205/MiM_Final_Report_finalv9.doc. The OST database profile of this program can be found online at: www.hfrp.org/MixinginMath.

5 Project Exploration, 2006.

6 Miller, B., 2009.

APPENDIX: RESEARCH ON STEM OST PROGRAMS FOR GIRLS

The Harvard Family Research Project's Out-of-School Time (OST) Program Research and Evaluation Bibliography is an online resource that contains citations for all of the OST program evaluations and research that HFRP is tracking. The goal of this appendix is to list all of the STEM OST programs (exclusively for girls, or with an emphasis on girls) from the OST Bibliography in one place, providing a cross-section of the wide variety of programs represented. Evaluations and studies that have been profiled in depth in the OST Program Research and Evaluation Database are noted as such and include a link to the corresponding profile in the OST Database.

Build IT

Funded to operate 2005 through 2008 in Alameda County, California, this afterschool and summer curriculum aims to develop low-income middle school girls' information technology (IT) fluency, interest in math, and knowledge of IT careers.

Koch, M. (2006). *Build IT: Girls developing information technology fluency through design annual report.* Menlo Park, CA: SRI International. **ctl.sri.com/publications/downloads/Y1BuildITAnnualReport_2006FIN.pdf**

Girl Game Company

This afterschool and summer program serves middle school girls in a rural part of central California. The goals are to increase girls' information technology fluency through computer-based activities, and to build peer, family, and other adult support to enhance girls' interest in and capacity to pursue and persist in computer courses and careers.

Denner, J., Bean, S., & Martinez, J. (2009). The Girl Game Company: Engaging Latina girls in information technology. *Afterschool Matters, 8*, 26–35. **www.robertbownefoundation.org/pdf_files/2009_asm_spring.pdf**

Girls at the Center

Initiated in 1996, this program pairs girls in economically disadvantaged communities across the country with an adult partner for experiences in science.

Abrams, C., Dierking, L., McKelvey, L., & Jones, D. (1998) *Year two report: Summative evaluation—Girls at the Center*. Annapolis, MD: Institute for Learning Innovation.

Adelman, L., Dierking, L. D., & Adams, M. (2000). *Summative evaluation year 4: Findings for Girls at the Center (Tech. Rep.)*. Annapolis, MD: Institute for Learning Innovation.

Girls Creating Games Program

VIEW PROFILE

This afterschool program in Capitola, California, aims to build middle school girls' interest, skills, fluency, and confidence in information technology.

Denner, J. (2007). The Girls Creating Games Program: An innovative approach to integrating technology into middle school. *Meridian: A Middle School Computer Technologies Journal, 1*(10). **www.ncsu.edu/meridian/win2007/girlgaming/index.htm**

Girls Inc.—Thinking SMART Program

VIEW PROFILE

Begun in 2002 and completed in 2007, this informal science and engineering project served adolescent girls at sites in Alabama, California, Indiana, Massachusetts, New Hampshire, New Mexico, and Tennessee. The program targeted girls from low-income and single-parent families, of diverse ethnic and cultural backgrounds, and with disabilities. The goals of the project were to increase girls' interest in pursuing education and careers in science, technology, engineering, and math fields.

Bruschi, B. (2008). *Final summative evaluation report: Girls Inc. Thinking SMART Program.* Indianapolis, IN: Girls Incorporated National Resource Center.

Girls Math and Technology Program

Initiated in 1998, this residential summer camp in northern Nevada is designed to impact middle school girls' attitudes about and perceived abilities in mathematics and technology.

Wiest, L. (2003). *The impact of a summer mathematics and technology program for middle school girls.* Reno, NV: Author.

DeHaven, M. A., & Wiest, L. R. (2003). Impact of a girls' mathematics and technology program on middle school girls' attitudes toward mathematics. *The Mathematics Educator, 13*, 32–37.

Hands on Science Outreach

This national afterschool recreational science enrichment program was created to encourage youth, pre-K to sixth grade, to take an active interest in science through a hands-on approach.

Goodman, I. F. (1993). *An evaluation of children's participation in the Hands on Science Outreach Program*. Cambridge, MA: Sierra Research Associates.

SDS & Associates. (1994). *1993–94 Hands on Science program report.* Memphis, TN: Author.

Mixing in Math

VIEW PROFILE

In operation from 2004 to 2009, this project helped afterschool educators across the U.S. mix math into what they already do with children in grades K–6 (e.g., crafts, cooking, games).

Miller, B. (2009). *Mixing in Math evaluation final report*. Brookline, MA: Miller Midzik Research Associates.
www.informalscience.org/reports/0000/0205/MiM_Final_Report_finalv9.doc

Newton Summer Academy

This summer academy was piloted in Columbus, Missouri, in 1997. The program was designed to increase or maintain high school girls' interest and participation in the physical sciences.

Chandrasekhar, M., Phillips, K. A., Litherland, R., & Barrow, L. H. (1999). *Science interests and experiences for high school girls in a summer integrated program*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Boston, MA. epic.physics.missouri.edu/PDF%20files/Narst_99_paper_a.pdf

Phillips, K. A. (2000). *High school females' interests in physical science and related careers one year after participation in a summer intervention program* (Unpublished doctoral dissertation). University of Missouri–Columbus.

Phillips, K. A., Chandrasekhar, M., Barrow, L., & Litherland, R. (2000). *Physical science interests and strong interest inventory profiles of females in a residential summer program*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA. epic.physics.missouri.edu/PDF%20files/NARST_2000_Paper.pdf

Oceanography Camp for Girls

Started in 1991, this educational program for girls in the summer before their ninth-grade year helps motivate them to consider career opportunities in the sciences. The program, located in St. Petersburg, Florida, encourages girls to understand the natural world and provides a multidisciplinary, hands-on/minds-on practical experience in both laboratory and field environments.

Butler, Y. J. (1999). *Introducing oceanography to eighth-grade girls: Evaluation of the Oceanography Camp for Girls, summer of 1998*. Philadelphia: Public/Private Ventures.

Project Exploration

VIEW PROFILE

Project Exploration's Chicago, Illinois-based out-of-school time youth programs seek to provide experiences with science and scientists to youth otherwise unlikely to have such opportunities. The primary goal is to afford these youth access to dynamic experiences with science, including science career path experiences and academic support to encourage college attendance.

Project Exploration. (2006). *Project Exploration: Youth programs evaluation*. Chicago: Author.
www.projectexploration.org/PDF/program-eval-v2-final.pdf

Project Mentor

Begun in 1997, this afterschool mentoring program matches middle school girls in New Hampshire with undergraduate mentors in order to improve the girls' academic achievement, attitudes toward math and science, self-esteem, and career aspirations.

Fachin Lucas, K. M. (1999). *Mentoring in adolescence: A sociocultural and cognitive developmental study of undergraduate women and sixth grade girls in a mentoring program* (Unpublished doctoral dissertation). University of New Hampshire, Durham.

SECME RISE (Raising Interest in Science & Engineering)

VIEW PROFILE

Begun in 1998, this 3-year program aimed to increase middle school girls' self-esteem and confidence in learning mathematics and science, therefore reducing the attrition in advanced-level mathematics and science coursework that occurs as girls move from middle school to high school.

Jarvis, C. (1999). *SECME RISE Raising Interest in Science & Engineering: Year one progress report.* Miami, FL: Miami Museum of Science.

Jarvis, C. (1999). *SECME RISE Raising Interest in Science & Engineering: Year two progress report.* Miami, FL: Miami Museum of Science.

Jarvis, C. (2002). *SECME RISE Raising Interest in Science & Engineering: Final evaluation report, September 1, 1998–August 31, 2001.* Miami, FL: Miami Museum of Science.

Sisters in Science Program

Begun in 1995 in Philadelphia, this program aims to improve fourth- and fifth-grade girls' attitudes, perceptions, and achievement in science and math by creating female-friendly learning environments in classrooms, after school, on Saturdays, during the summer, and with families.

Hammrich, P. L., Richardson, G., & Livingston, B. (2001). *The Sisters in Science Program: A three year analysis*. Philadelphia: Author. www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/f7/79.pdf

Hammrich, P. L., Livingston, B., & Richardson, G. (2002). *The Sisters in Science Program: Barriers broken and lessons learned*. Philadelphia: Author.

Hammrich, P. L., Fadigan, K., & Stull, J. (2008). *Sisters in Science in the community: An informal gender equity program*. Flushing, NY: Sisters in Science. www.informalscience.org/evaluations/report_276.PDF

STUDIO 3D

VIEW PROFILE

Initiated in 2000, this Minnesota-based afterschool outreach program provides youth—aged 10–18 and living in low-income, inner-city neighborhoods in Minneapolis and St. Paul—with access to equipment, software, and adult mentors to support them in learning and applying advanced digital design technologies.

Volkov, B. B., & King, J. A. (2003). *Report of STUDIO 3D project evaluation*. Minneapolis: University of Minnesota, Department of Educational Policy and Administration, Evaluation Studies Program. www.smm.org/studio3d/mission.html

Society of Women Engineers and ExxonMobil Education Foundation's After-School Science Program

Initiated in 1999, this afterschool science program pairs minority female urban middle school students with female engineer mentors to work in cooperative learning groups with hands-on/minds-on activities. Mentors act as role models to positively influence girls' attitudes toward science.

Ferreira, M. M. (2001). The effect of an after-school program addressing the gender and minority achievement gaps in science, mathematics, and engineering. *ERS Spectrum, 19*(2), 11–18.

TechREACH

Launched in 2003, this afterschool program targets low-income, at-risk middle school girls in western Washington State and engages them in science, mathematics, engineering, and technology (STEM) activities to increase their interest in STEM with high-quality curricula and real world projects.

Molloy, P., & Aronson, J. (2004). *TechREACH: Year 1 evaluation report*. Bothell, WA: Puget Sound Center for Teaching.

Molloy, P., & Aronson, J. (2005). *TechREACH: Year 2 evaluation report*. Bothell, WA: Puget Sound Center for Teaching.

www.techreachclubs.org/programs/evaluations.html

Wonderwise Sleepovers

Using Wonderwise kits (designed to be used as a curriculum to promote science to young girls), teachers at Lincoln Public Schools in Nebraska organized a series of science sleepovers for fifth and sixth grade girls in 1998 and 1999.

Spiegel, A. N. (2002). *Evaluation of Lincoln Public Schools' Wonderwise Sleepovers: Brief summary and compilation of five individual reports, with example questionnaires*. Lincoln: Center for Instructional Innovation, University of Nebraska–Lincoln.
wonderwise.unl.edu/research/pdfs/Sleepover_Report.pdf

ABOUT HARVARD FAMILY RESEARCH PROJECT

Since 1983, we have helped stakeholders develop and evaluate strategies to promote the well-being of children, youth, families, and communities. Our work focuses primarily on three areas that support children's learning and development—early childhood education, out-of-school time programming, and family and community support in education.

Building on our knowledge that schools alone cannot meet the learning needs of our children, we also focus national attention on complementary learning. Complementary learning is the idea that a systemic approach, which integrates school and nonschool supports, can better ensure that all children have the skills they need to succeed. Underpinning all our work is our commitment to evaluation for strategic decision making, learning, and accountability.

Harvard Family Research Project

3 Garden Street, Cambridge, MA 02138
Tel: 617-495-9108 Fax 617-495-8594
Email: hfrp_pubs@gse.harvard.edu
Website: www.hfrp.org

HARVARD GRADUATE SCHOOL OF EDUCATION