Great Science for Girls: Gender-Equitable STEM & Afterschool Programs

By Cheri Fancsali and Merle Froschl

Introduction

Trend data show that girls and women have made substantial gains in the last three decades in terms of educational equity (NCES, 2000). They are doing as well or better than their male peers on many indicators of educational achievement and attainment. However, they still lag behind their male peers in aspects of mathematics and science achievement and advancement towards, and attainment of, careers in science, technology, engineering, and mathematics (STEM).

For example, girls and boys perform at similar levels in mathematics and science in elementary school, but girls show less positive attitudes toward science (Weinburgh 1995). While girls comprised a small majority (54%) of the advanced placement test-takers in 2001, they were underrepresented in the areas of mathematics and science (College Board, 2001). Further, although the gap has decreased in the last decade, males still outperform females on high-stakes tests such as the SAT and ACT (Sadker, 1999). Girls are also much less likely to major in science-related fields in college and less likely to complete undergraduate and graduate STEM degrees (Clewell, Anderson, and Thorpe, 1992; Davis, et al, 1996; NSF, 2000). They comprise a disproportionately low percentage of the STEM workforce, earn less, and are less likely to hold high-level positions in STEM careers (Long, 2001; NSF, 2000).

While this situation needs to be addressed on several fronts, the field of afterschool offers unique opportunities to help increase girls' interest and participation in STEM education and careers. Girls have fewer out-of-school science experiences than boys (Farenga, 1995; Kahle, et al., 1993), and this has been related to girls' reduced participation in school science courses (Farenga, 1995). This article outlines some of the issues related to increasing girls' participation in STEM education and careers and the role afterschool can play in facilitating girls' interest and participation in these areas. First, the article describes what all students need to be successful in STEM, followed by a discussion of why afterschool is an ideal setting for STEM content. Next, strategies promoting girls' STEM participation and achievement and how this relates to the characteristics of effective afterschool programs are discussed. Finally, a new resource for practitioners, researchers and policy makers, The Science, Gender and Afterschool Community of Practice, is described. Additional resources related to STEM, gender and afterschool are also included.

What Girls (and Boys) Need to be Successful in STEM

Based on their review of the literature and discussions with leaders in STEM, Jolly, Campbell and Perlman (2004) propose three factors that are nec-

essary for student success in STEM: engagement, capacity and continuity. According to Jolly et. al., one piece of the "trilogy" is that students must be engaged—have the awareness, interest and motivation towards science. Another factor is that students must have capacity in terms of knowledge and skills needed to advance in STEM disciplines. The third factor is continuity--students must have opportunities and resources to support advancement in STEM disciplines. These three factors are interdependent and, on an individual basis, are not sufficient to produce student success. Together, they provide the opportunities and supports students need to participate and succeed in STEM coursework and careers.

Why Afterschool?

Afterschool can play a critical role in providing girls with engagement, capacity and continuity in STEM disciplines. For example, afterschool programs can expose girls to a wide-variety of STEM careers and diverse role models to dispel stereotypic notions of who does science. Further, the afterschool arena is uniquely well-suited to provide learning experiences that can help girls (and boys) make a personal connection to science (AAUW, 2004; Froschl, Sprung, Archer & Fancsali, 2003; Freidman and Quinn, 2006). Afterschool science puts science in a different context – one that offers social and psychological supports that help overcome obstacles to participation in STEM careers (Walker, Wahl and Rivas, 2005). In addition, science in afterschool fosters improved attitudes and enthusiasm among girls and other underserved groups (Freidman and Quinn, 2006).

A total of 6.5 million children are enrolled in afterschool programs (Afterschool Alliance, 2004). A large proportion of these children (estimated to be 20% to 25%) are low-and moderate-income urban children, and the number appears to be growing (Halpern, 2002). The focus of afterschool on the importance of the voice of the young person, and the very fact that afterschool is not school, may make this environment particularly conducive to inquiry learning experiences (Walker, Wahl and Rivas, 2005; Froschl, Sprung, Archer & Fancsali, 2003). Research further indicates that the less school-like nature of afterschool, where girls often identify with their instructors, has a positive impact on encouraging girls in STEM (Campbell, Storo and Acerbo, 1995).

Experts also agree that afterschool can help youth foster decision-making and leadership skills, engage in learning, provide opportunities to explore interests, and connect with caring adults and older youth (Bodilly and Beckett, 2005; Miller, 2003). These are important "prerequisites" to learning (Miller, 2003) that will help students in any subject. Further, studies have shown that afterschool programs can offer youth opportunities not available during day school, and that engaging afterschool activities foster students' intrinsic motivation, and that youth put forth more concerted effort in these settings (Vandell et. al., 2005). These characteristics can be particularly helpful in the effort to increase girls' interest and participation in STEM coursework and careers.

Strategies Promoting Girls' STEM Participation and Achievement

Many of the characteristics of good afterschool programs are the very ones that foster girls' participation and achievement in STEM. Recent research suggests that programs adhering to a youth-development framework are more likely to promote positive youth outcomes (Gambone, Klem & Connell, 2002; Bouffard & Little, 2004; James et. al., 2001; McLaughlin, 2000; National Research Council and Institute of Medicine, 2002; Roth and Brooks-Gunn, 1998).

Characteristics of effective afterschool programming and a youth-development framework in-clude opportunities for youth to:

· experience supportive relation-ships and receive emotional and moral support;
• feel a sense of belonging;
• be exposed to positive morals, values, and positive social norms;
• be efficacious, to do things that make a real difference, and play an active role in the program;
• develop academic and social skills, including learning how to form close relationships with peers that support and reinforce healthy behaviors, as well as acquire the skills necessary for school success and a successful transition to adulthood (National Research Council and Institute of Medicine, 2002, p. 117).

Research points to several practices that promote an equitable learning environment for girls and have a positive impact on their continuation in quantitative disciplines and science. They include collaborative learning, hands-on experiences, an emphasis on practical applications, and the teach-

ing of science in a more holistic and social context (Campbell et al, 2002; Davis and Rosser, 1996; Hansen, et al., 1995; Koch, 2002; Lee, 1997; Wenglinsky, 2000). Many researchers also agree that mentors, role models, and networks are important beginning in the early grades and throughout a woman's career (Astin and Sax, 1996; Clewell and Darke, 2000; Hansen et al., 1995; Thom, 2001). Programs for girls combining hands-on activities, role models, mentoring, internships, and career exploration have improved girls' self-confidence and interest in STEM courses and careers and helped reduce sexist attitudes about STEM (Campbell and Steinbrueck, 1996; Ferreira, 2001).

Related to the findings about the impact of mentors and role models, studies have found that support from adults can play a key role in encouraging girls. One Girls Incorporated study, The Explorer's Pass, showed that girls in mathematics and science classes and programs benefited from adult encouragement and modeling to overcome "a reluctance to get dirty and a tendency to ask for adult rescue when a task seemed difficult or boring" (Girls Incorporated, 1991, p. viii). The study also found that girls needed a supportive environment to pursue interests, take (reasonable) risks, not fear making mistakes, and use "mistake making" as a method of learning. An AAUW report, Girls in the Middle: Working to Succeed in School, showed the importance of adults fostering an atmosphere of respect for girls' voices and approaches to learning, whether or not they conform to the dominant culture of the school (Cohen, et al, 1996).

In addition to collaborative learning, mentors and role models, Hansen, Walker, and Flom, authors of Growing Smart: What's Working for Girls in Schools, found evidence that girls are more likely to thrive in a learning environment that provides:

- opportunities for leadership and exploration of new ideas;
- active, intelligent engagement with concerned adults and other students; and
- consciousness-raising about gender, race, and class issues (Hansen, et al., 1995).

Employing the strategies highlighted here will help ensure that girls have afterschool opportunities that foster engagement (awareness, interest and motivation) in STEM content, increase capacity in terms of STEM knowledge and skills, and facilitate continuity by supporting advancement into increasingly rigorous content in STEM course work and careers (Jolly, et. al., 2004)—the three factors critical for student success.

The Science, Gender and Afterschool Community of Practice

All of the characteristics of high-quality STEM afterschool experiences for girls are dependent upon a strong foundation of high-quality staff (Bouffard & Little, 2004; NOIST, 2003; C.S. Mott Foundation Committee on After-School Research and Practice, 2005). Yet, afterschool staff are often underprepared, especially in the area of STEM content, and undersupported in their professional growth. Further, the field is challenged by high staff turnover and low retention rates. However, evaluations conducted at the state and national level have shown that professional development for afterschool staff can have an impact on practitioner knowledge and improving program practices (Bouffard & Little, 2004).

Addressing the need for professional development to facilitate high-quality afterschool programs with a focus on Great Science for Girls requires creative solutions. One promising practice is the web-based Science, Gender and Afterschool (SGA) Community of Practice, an interactive forum for practitioners, researchers and policymakers (see http://www.afterschool.org/sga/). The SGA Community of Practice is a collaboration between the Educational Equity Center at the Academy for Educational Development (EEC/AED) and the American Association for the Advancement of Science (AAAS), with funding from the National Science Foundation. It addresses two key characteristics of effective professional development: 1) the need for professional development to be collaborative, involving sharing knowledge with others, and 2) the need for it to be on-going. The SGA Community of Practice includes a listserv, offers live webcasts on new research and strategies, and contains numerous resources to strengthen the role of afterschool education in increasing girls' participation in STEM.

The SGA Community of Practice is an extension of the 2002 Science, Gender, and Afterschool Conference, co-sponsored by EEC/AED and AAAS. At the conference, participants developed Science, Gender, and Afterschool: A Research-Action Agenda, which is available on the SGA Community of Practice Website. The Agenda divides SGA research into three key areas: recruiting girls to afterschool programs and retaining them once they've joined; program content and pedagogy; and staffing and professional development. The SGA Community of Practice includes discussion of these issues along with links to research materials, curriculum information, and other organizations dedicated to

advancing STEM education through afterschool programs.

The SGA Community of Practice is a growing resource to the field of afterschool education. Such online forums offer a way to supplement other "live" professional development experiences and facili-tate a community of practice for afterschool staff. Online technology increasingly is providing a platform to reach far greater numbers of administrators, teachers, afterschool personnel, and parents, and one that should be exploited to its fullest potential in the effort to build on afterschool's unique position to offer gender equitable STEM experiences to all youth.

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Resources

BOOKS

Athena Unbound: The Advancement of Women in Science and Technology. **Henry Etzkowitz, Carol Kemelgor, and Brian Uzzi.** Cambridge, 2000. 281pp. $54.95. ISBN 0521563801.

Balancing the Equation: Where are Women and Girls in Science, Engineering and Technology? **Mary Thom.** National Council for Research on Women, 2002. 174pp. $22.00. ISBN: 1880547260.

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Girls and Young Women Inventing: Twenty True Stories about Inventors Plus How You Can Be One Yourself. **Frances Karnes and Suzanne M. Bean.** (Illus.) Free Spirit Press, 1995. 168pp. $12.95. ISBN 0-915793-89-X.

Journeys of Women in Science and Engineering: No Universal Constants. **Susan A. Ambrose et al.** (Illus.) Temple University Press, 1997. 461pp. $59.95. ISBN 1-56639-527-5.

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Women in Mathematics: Scaling the Heights. **Deborah Nolan (Ed.).** (Illus.) Mathematical Association of America, 1997. 130pp. $29.95. ISBN 0-88385-156-3.

Women and Science: Social Impact and Interaction. **Suzanne Le-May Sheffield.** (Illus.) Rutgers, 2005. 412pp. $29.95. ISBN 0-8135-3737-1.

Young Women of Achievement: A Resource for Girls in Science, Math, and Technology. **Frances E. Karnes and Kristen R Stephens.** Prometheus, 2002. 300pp. $21.00. ISBN 1-57392-965-4.

WEB SITES

Girls at the Center
http://www.fi.edu/tfi/programs/gac.html
A curriculum produced from a national collaboration between The Franklin Institute and Girls Scouts of the USA to encourage family involvement in girls' science learning. The Girls at the Center program is designed to be effective in multiple settings, including afterschool programs.

Girls Inc., Operation SMART (Science Math And Relevant Technology)
http://www.girlsinc.org/ic/page.php?id=1.2.1
Girls Incorporated launched Operation SMART in 1985. In hundreds of sites across the country, close to a quarter of a million girls between the ages of 6 and 18 have started on the path to becoming engineers, auto mechanics, microsurgeons, and astronauts. They're asking questions, making guesses, taking chances.

Girl Start
http://www.girlstart.org/
A non-profit organization created to empower girls to excel in math, science, and technology. Founded in 1997 in Austin, Texas, Girlstart engages, educates, and motivates girls to achieve the knowledge and confidence to participate in advanced math and science classes and future careers. Girlstart offers a variety of educational formats designed for middle school girls through after-school programs, Saturday camps and summer camps.

Girls Tech
http://www.girlstech.douglass.rutgers.edu/
GirlsTech explains and demonstrates a framework for use by teachers, parents, and youth group leaders to evaluate electronic resources (Web sites, CD-ROMS, software, and games) that will encourage and increase young women's interest and participation in the sciences and technology. GirlsTech is a program of Douglass College, the undergraduate women's college of Rutgers, The State University of New Jersey.

MIT Women in Technology Program
http://wtp.mit.edu/
A summer program at the Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science (EECS) to introduce high school girls to EECS in the summer after 11th grade. Forty participants are selected each year from a nationwide applicant pool of young women who have demonstrated outstanding academic talent in math and science. The Women in Technology program has just introduced a new summer program in mechanical engineering.

PDK Poster Project
http://www.pdksciart.com/index.htm
The PDK Project has two major goals: to promote "awareness and appreciation of science and technology by humanizing the image of research science and scientists" and to support women and girls who choose to pursue careers related to the physical sciences and mathematics. The site's resources include 36 visually stunning posters; study guides to accompany each poster; videos, interviews, and biographies of the poster participants; links to related sites; and more.

Sally Ride Science
http://www.sallyridescience.com/
Sally Ride Science was founded in 2001 by former astronaut Sally Ride—America's first woman in space. The company's mission is to empower girls to explore the world of science—from astrobiology to zoology and from environmental engineering to rocket science. They do this by creating innovative, high quality programs and publications for girls and their parents, teachers, and future employers. The program's goal is to increase the number of girls who are technically literate and who have the foundation they need to go on in science, math, or engineering.

Sisters in Science
http://www.sistersinscience.org/
The SIS program, sponsored by the Equity Studies Research Center at Queens College, City University of New York, addresses the needs of urban girls in gaining equitable access to science, technology, engineering, and mathematics (STEM) education. Through science explorations developed to promote gender equity in STEM disciplines, elementary school girls achieve STEM disciplines in a non-competitive and collaborative atmosphere.

Tech Bridge
http://www.techbridgegirls.org/
An after school program for middle and high school girls that demystify technology. Activities build both skills and confidence in handling technology, and address girls' needs and interests. This program is sponsored by the Chabot Space & Science Center (CSSC) an innovative teaching and learning center focusing on astronomy and the space sciences and the interrelationships of all sciences.

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respondents identified their primary role as postsecondary educators; 19% indicated researcher or postdoctoral scholar; 14% indicated K-12 teacher; and 6% indicated curriculum developer.

Respondents to the BEN User Survey found the portal primarily through links from other websites (32%), but also via their own web searches (18%), and through referrals from articles (16%). Others found the portal through colleagues (13%), workshops or exhibits (6%), or the NSDL website (5%). They came to the portal primarily to find lecture resources (67%) and to enhance their own teaching and learning (60%). Thirty-nine percent (39%) were seeking resources for student assignments and independent projects.

Analysis of the responses by groups indicated that the different groups had different needs and uses for the resources available at the BEN portal. Seventy-nine percent (79%) of post-secondary educators were seeking resources for lectures, while 80% of K-12 educators were seeking resources to enhance their own teaching and learning A majority of respondents who were researchers (63%) were seeking resources that were related to the research that they were conducting in their fields.

When respondents to the BEN User Survey were asked what actions, if any, they had undertaken as a result of visiting the portal or digital libraries of the collaborators, more than half of all respondents indicated that they downloaded a resource and used resources in teaching or research (57%). Forty-six percent (46%) of the respondent indicated they incorporated new ideas and thinking into their teaching or research. This data suggest that BEN is having an impact on teaching and learning in the biological sciences.

The primary funder of the BEN Pathway and the NSDL (http://nsdl.org) is the National Science Foundation (NSF). The NSDL was created by the NSF *to provide organized access to high quality resources and tools that support innovations in teaching and learning at all levels of science, technology, engineering, and mathematics education*. The development and management of the NSDL is facilitated though the collaborative efforts of the University Corporation for Atmospheric Research, Cornell University, and Columbia University.

Other NSDL Pathways include the Computational Sciences (http://www.shodor.org); Engineering (http://www.teachengineering.com and (http://www.needs.org); Materials Sciences (http://www.matdl.org); Mathematical Sciences (http://mathdl.maa.org); Middle School (http://msteacher.org); Multimedia Resources for the Classroom and Professional Development (http://www.teachersdomain.org); and Resources and Services for Community Colleges (http://amser.org).

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http://books.nap.edubooks/0309085357/html/index.html

State High School Exit Exams: States Try Harder, But Gaps Persist (2005) Patricia Sullivan, Margery Yeager, Naomi Chudowsky, Nancy Kober, Eileen O'Brien, and Keith Gayler. Center on Education Policy. Washington, DC. *http://www.cep-dc.org/highschoolexit/*