
AC 2012-4502: K-CAREER DIRECTIONS FOR WOMEN

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Stacy Klein-Gardner's career focuses on K-12 science, technology, engineering, and mathematics (STEM) education, particularly as it relates to increasing interest and participation by females. Klein-Gardner serves as the Director of the Center for STEM Education for Girls at the Harpeth Hall School in Nashville, Tenn. Here, she leads professional development opportunities in science, technology, engineering, and mathematics (STEM) for K-12 teachers and works to identify and disseminate best practices from successful K-12, and university and corporate STEM programs for females. This center also leads a program for rising ninth and 10th grade girls that integrates community service and engineering design in a global context. She continues to serve as an Adjoint Professor of the Practice of Biomedical Engineering at Vanderbilt University, where she runs NSF-funded programs such as Research Experiences for Teachers (RET), one of the most long-standing RET programs in the U.S. She has served as the Associate Dean for Outreach in the Vanderbilt School of Engineering from 2007-2010. She established the Metropolitan Nashville Public Schools (MNPS) engineering pathway from K-12 with Race to the Top funding in 2010-2011.

K-Career Directions for Women

Abstract:

A newly funded Center for STEM Education for Girls has been created at the Harpeth Hall School in Nashville, TN. A primary goal of this new center is to create collaborations among leading girls' schools, university programs with successful STEM programs for women, informal education for girls, and corporations whose cultures enable and enhance the success of women in STEM fields. In November, thirty members from these groups gathered to further define the Center's mission and to create research questions and programmatic goals around the next steps needed. This group drew upon the expertise and research backgrounds of many and utilized a group method known as Open Space. This work-in-progress reports out on the research and programmatic agendas set by this unique group of STEM leaders for females. These agendas will be informative not only for the Center itself but for other researchers and STEM educators and employers of women.

Introduction:

Establishment of new Center and goals

With outstanding math and science programs, the Harpeth Hall School is intentionally encouraging and preparing young women to pursue STEM studies and STEM careers. Harpeth Hall is an all girls independent school for grades 5-12 in Nashville, TN. Its mission is to help each student realize her highest intellectual ability in the sciences, the humanities, and the arts, and discover her creative and athletic talents. Harpeth Hall develops responsible citizens who have global perspectives and make meaningful contributions to their communities and the world. With a tradition of excellence and a commitment to life-long learning, Harpeth Hall educates young women to think critically, to lead confidently, and to live honorably. For more information, visit www.harpethhall.org.

Through our recent Educational Leadership Grant from the Edward E. Ford Foundation, the Harpeth Hall School has an opportunity to expand and extend our commitment to STEM studies for girls in the Nashville community and beyond by establishing the *Center for STEM Education for Girls* (<http://www.stemefg.org>). This new Center will fill a unique niche in the growing and vast landscape of STEM groups nationwide, with its membership that spans K-12 to university to corporate (with informal educators as well) and comes out of the K-12 community rather than higher education. The Center also focuses on the unique needs of female learners and STEM participants. The Center will draw upon the rich resources of groups such as WEPAN¹, who focuses more on university and corporate members, and the STEM Equity Pipeline² to fulfill its goals.

Over the five-year period of the grant, the goals of the *Center for STEM Education for Girls* are as follows:

- **Enhance our annual *STEM for Girls Think Tank* founded at the Harpeth Hall School in 2007 by creating the *STEM Consortium*.** Building upon Harpeth Hall's success in convening STEM educators on the Harpeth Hall campus annually since 2007 for our STEM Think Tank, Dr. Klein-Gardner has created a *STEM Consortium* which is a new leadership group comprised of STEM leaders at K-12 girls' schools, university-level STEM programs with strong female participation, university researchers in STEM education, STEM corporations with welcoming cultures for women, and other informal education groups who serve girls. These STEM national experts will convene at Harpeth Hall on an annual basis.
- **Create a summer *STEM for Girls Think Tank and Conference* that will build upon the outcomes of the *STEM Consortium* and will benefit teachers of girls.** The Harpeth Hall School will host our first annual *STEM Think Tank and Conference* July 18-20, 2012, in the new expanded format. STEM teachers face the daunting task of remaining current in their fields which are undergoing dramatic and rapid change. Scientific discoveries, new technologies, and research into the unique learning style of girls have led to major changes in curriculum and teaching standards which STEM teachers must master to remain current. Our two-day conference will offer STEM teachers of girls the opportunity to receive essential professional development. Grant funding also will provide scholarships for teachers from underserved public and charter schools to attend. Additionally, the Think Tank and Conference aims to provide the opportunity for K-12, university, and corporate leaders to exchange ideas and knowledge on what works best for women and what keeps them in the STEM "pipeline".
- **Develop a replicable summer *STEM Institute for Girls* that will offer intensive experiences in STEM fields for young women entering ninth and tenth grades in schools in the greater Nashville area.** The first annual *STEM Institute for Girls* will take place June 18-29, 2012. The Institute is a two-week summer program with an integrated curriculum focusing on one or two challenge problems that need to be solved, with supporting 'classes' that help solve the problem across the STEM disciplines. In 2012, our plans are based in both service learning and engineering design within a global context. The Lwala Community Alliance has "hired" the participants to improve the design of the tippy-tap handwashing stations used in their girls' schools in Kenya. Participants will use the engineering design process to manage the redesign along with appropriate scientific inquiry, statistical analyses, CAD drawings, and hands-on prototype building to accomplish this task. Getting girls interested and involved in STEM studies early is important. Hence, the target enrollment each year is 30 girls entering high school or after their freshman year, with 75% of the students coming from non-magnet

Metropolitan Nashville Public Schools through an application process based on essays and teacher recommendations. Scholarships will be available on a sliding scale. Our goal is to inspire these young women by offering challenging courses and providing positive female role models in STEM careers. In the budget is funding beginning in year two for leaders from other girls' schools to attend part of the Institute so that they may more easily implement the program in their own school.

Elaboration on Consortium group membership

The membership of the Consortium was designed to include voices from K-12 schools through university and into industry. Specifically, two members each were chosen from nine all girls' schools who have been leaders in the STEM Think Tanks that were held by Harpeth Hall in the past three years. Member schools are listed in Table 1.

Table 1. K-12 School Consortium Members.

School	Location
Harpeth Hall School	Nashville, TN
Hutchison School	Memphis, TN
Marymount School	New York, NY
Online School for Girls	Washington, DC
Holton-Arms School	Bethesda, MD
Garrison Forest School	Owings Mill, MD
Hockaday School	Dallas, TX
Laurel School	Cleveland, OH
Westover School	Middlebury, CT

Upon reviewing published data about the enrollment and persistence of women in a variety of STEM fields, faculty leaders from representative programs were invited to join the Consortium. The current university level members are listed in Table 2. Additional members may be recruited to join to increase the breadth of STEM subjects and successful programs represented.

Table 2. University Consortium Members.

School	Location
Vanderbilt University School of Engineering	Nashville, TN
Vanderbilt University College of Arts and Science	Nashville, TN
Duke University, Pratt School of Engineering	Durham, NC
University of Maryland Baltimore College School of Engineering	Baltimore, MD
Boston University, Mathematics Department	Boston, MA

Because informal education has the power to play important roles in the lives of young women, representatives from this field were invited to join the Consortium as well. Their organizations are listed in Table 3.

Table 3. Informal Education Consortium Members.

Organization	Location
Girl Scouts of Middle Tennessee	Nashville, TN
New York Hall of Science Museum	New York, NY

Increasing female’s access to and interest in industrial careers in STEM is important to the Center. As a result, representatives were invited to join the Consortium and they are listed in Table 4. Additional members will be invited in the future as they are identified. Since the first meeting of the consortium, ExxonMobil of Houston, TX, has joined this group.

Table 4. Industrial Consortium Members.

Corporation	Location
Nissan North America	Franklin, TN
Roche Diagnostics	Indianapolis, IN

Finally, the Center for STEM Education seeks to learn from and generate its own research. Accordingly, two additional university level members were invited to join the Consortium to push the Center in this direction and lead some of the research along with the Center’s director and author of this paper. Also since the first meeting of the consortium, a member from the National Academies has joined.

Table 5. Researcher Consortium Members.

School	Location
Clemson University	Clemson, SC
University of Oklahoma	Norman, OK

Method:

The first Consortium meeting was held November 9-11, 2011, at the Harpeth Hall School. Members were given the following goals for the meeting:

- Refine goals given in the grant
- Establish next steps
- What are best practices?

- What research questions do we have?
- What does the center need to do?
- What are the conference strands?

After establishing broad guidelines for the Think Tank & Conference, the STEM Summer Institute, and the clearinghouse functions of the Center, an Open Space Method³ was used to facilitate the meeting itself. Because the members were unfamiliar with this style of meeting, it was explained to them that this style of meeting was meant to create a generative and inclusive environment, take advantage of the collective wisdom and ideas of the group, and not rely exclusively on leadership to know what the best topics are for discussion and future work.

The Open Space method works as follows:

- Generate a topic that you would like to discuss around the general topic of establish goals for the Center
- Post that topic during a meeting time and in a specific location
- Chair that meeting, keeping it on time (40-45 min)
- Take minutes on the laptop in the room
- Email minutes to the meeting leader
- Vote on most important topics
- Establish action plans
 - What needs to be done
 - Rank A, B, C for how important it is
 - Assign people to complete the tasks

Results:

The first annual STEM Consortium meeting was held at The Harpeth Hall School November 9-11, 2011. This group is comprised of STEM leaders at K-12 girls' schools, university-level STEM programs with strong female participation, STEM corporations with welcoming cultures for women, and other informal education groups who serve girls. Each year this group will provide leadership and guidance to the new Center for STEM Education for Girls. This year the Consortium worked on two main tasks: setting goals and priorities for the Center and determining the theme and conference strands for the upcoming Think Tank and Conference.

The Consortium members present developed fourteen topics for discussion and ultimately selected the five bolded topics priorities for the Center.

- How do we support K-5 teachers in teaching STEM?
- How do the college institutions that retain STEM majors do it? How do we transition from secondary to university effectively?
- **What do we know? What do we need to know to keep women in STEM? Create a literature survey and summary and disseminate it broadly. Identify holes in the literature for future projects and grants.**
- Are we pushing girls too far too fast in upper school science curriculum?
- How do we reinforce with girls that they can be successful in their STEM careers? How do we vaccinate against the Imposter Syndrome?
- Using research in the classroom
- **Online education – Create a position statement on blended learning in STEM courses (especially a lab course) with guiding principles**
- **Changing the Conversation / Messaging – What message do we send to girls about STEM? Gather and disseminate existing resources for students, parents, and educators.**
- Why the difference between Physics and Engineering and the other sciences as far as participation by women?
- Reasons NOT to go into a STEM career
- **Supporting girls in STEM: Secondary through College – Create regional summer “boot camps” and “booster camps” for girls going into STEM majors with regional secondary/higher-ed partnerships.**
- **Failure as a part of the Creative / Learning Process (and making it a positive experience) – Gather and disseminate relevant literature. Create best practices repository for relevant curriculum and assessment tools.**

Additionally, the Consortium membership was used to generate the conference theme and strands. The Think Tank and Conference will continue to build upon the successful previously held Think Tanks. The new dates are July 18-20, 2012, and it will be held at The Harpeth Hall School. The group has set “Changing the Paradigm: Lessons Up & Down the Pipeline – K12 to university to corporate” as the conference theme for 2012. Conference strands have been selected as follows:

- Best Practices in Curriculum & Teaching for Girls
- Girls in Coed Schools
- Getting Started in STEM – What do we mean? How is it different? How do you do it?
- Changing the Conversation – What message do we send to girls about STEM?

- Community Outreach - How can schools use local museums, universities, science centers, and businesses to give girls hands-on experiences and access to STEM careers?

Discussion:

In any research field, it is important to have both a literature base and a current research agenda. For example, the field of engineering education as a whole has had its research agenda defined in part by the Journal of Engineering Education and its authors⁴⁻⁶.

The Center for STEM Education for Girls will begin its work by *not* reinventing the wheel. Considerable research has gone into what creates effective learning environments for females and this work needs to be disseminated effectively to classroom teachers at every level. The Center must first begin by effectively accomplishing this goal through its website clearinghouse and other means.

The topics selected by the Consortium to be addressed first tended to be the broader topics, which naturally appeal to more people. Many of the participating K-12 schools are also early and frequent adopters of educational technology and new research in pedagogy; this is reflected in the focus on on-line coursework. Topics such as needing to change the conversation and teach the girls the role of failure came both out of the literature and from the personal experiences of many participants at all levels.

It is important to note that this current research agenda and call to action has been defined not just by researchers, but by those who must enact the best practices and by a group of leaders from across the stages of a woman's academic and professional life. We believe that this is a powerful call, made by a unique group of stakeholders.

Conclusions:

The work of this Consortium leadership group of the Center for STEM Education for Girls has put forth a research agenda for STEM education for females. The Center encourages researchers to pursue research questions in these areas, with or without the collaboration of the Center.

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