

THE GROW PROJECT: ESTABLISHING A SCHOOL/UNIVERSITY/INDUSTRY/GOVERNMENT NETWORK

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Abstract *¾ Over the past 100 years, networks have been deployed as a strategic tool to break barriers and increase opportunities for women in all fields. This has been particularly important for science and engineering. In this paper we briefly review the history and the impact of some of these networks. We also describe the creation and implementation of a new project called Girls Researching Our World (GROW), funded through the National Science Foundation (NSF). GROW is aimed at increasing and sustaining the interest of middle school girls in science, mathematics, engineering, and technology (SMET) disciplines and careers. GROW's goals are accomplished through a network consisting of university faculty, public school teachers and counselors, and professionals in government, private industry and non-profit organizations. Members of the network already have developed, supported and carried out a two-day hands-on workshop and industry tours for middle school girls.*

Index Terms *¾ middle school, network, environmental stewardship.*

INTRODUCTION

The GROW (Girls Researching Our World) Project is a National Science Foundation funded project aimed at increasing and sustaining the interest of middle school girls in science, mathematics, engineering, and technology (SMET) disciplines and careers. The project uses environmental stewardship as a conceptual hook to foster the interest of middle school girls in SMET.

One of the primary goals of the GROW Project is to build and sustain a network of individuals and groups who are committed to achieving gender equity in SMET. The concept of a network to foster change and achieve gender equity is not new. The major efforts for achieving gender equity in the past have utilized both formal and informal networks as tools. In the next section we briefly describe how networks have shaped women's opportunities in science and engineering over the past 100 years in the United States, with attention to their impact at Kansas State University (K-State).

HISTORICAL CONTEXT

In 1863, seven women and seven men embarked on a new educational enterprise as the first freshman class at Kansas State University, the nation's first land-grant institution. However, the opportunities for women to pursue graduate education were still limited, indeed almost non-existent. In 1882, the Association of Collegiate Alumnae (ACA; later the American Association of University Women (AAUW)) was founded. Over the next 30 years, the ACA led an organized effort to open graduate education and professorial positions in science and engineering to women. This effort combined compensatory and transformative strategies, including financial support for American women to obtain graduate degrees in German universities [1]. One of the beneficiaries of that effort was Mary Winston, who in 1896 became the second American woman to earn a PhD (magna cum laude) in Germany. She came to K-State and chaired the mathematics department from 1897 to 1900. This significant achievement for women at K-State was short-lived. Winston's departure from K-State was precipitated by her marriage, since at that time K-State insisted that its faculty women (but not men) be single [2].

Nevertheless, women continued to advocate for admission to American graduate schools. "The opening wedge" of German doctorates and "exceptions" or "special-case admissions" eventually led to policy changes explicitly permitting the admission of women [1]. This work was not completed until the 1960's, when institutions like Princeton finally admitted women to their graduate programs.

The ACA strategy represents an early example of the power of networking to help individuals achieve their goals and surpass limitations imposed by others. It also shows that helping individual women achieve their goals is an effective strategy for structural and societal change. The AAUW continues this strategy today with extensive support of individual women graduate students via the Selected Professions Fellowship Program for women in engineering, mathematics, and computer science [3].

Another example of the power of networks is the role that American women played in enabling Marie Curie to

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continue her research after World War I. Radium was extremely expensive. Ironically, the woman who first isolated this element could not afford to purchase it to continue her experiments. Marie Meloney, an American journalist, spearheaded a subscription campaign to raise the funds that would allow Curie to purchase sufficient quantities of radium. Women all over America responded overwhelmingly, and raised enough money to purchase a gram of radium [4].

During the 1930s, the nation's economy couldn't support significant employment in basic research. The 1950s brought both economic prosperity and a commitment to basic science and technology. Yet women, who had by 1940 become an integral part of American science, found themselves marginalized and underutilized because of a network of discriminatory policies and practices [1, 5]. In the mid-1900's several organizations were founded to specifically support women in scientific and engineering disciplines. The Society of Women Engineers (SWE) was founded in 1951, a particularly critical time for women in engineering. During WWII, the federal government had encouraged women to enter technical jobs to fill labor shortages. In the post-WWII period, the federal government urged them to leave these jobs to make room for returning GIs. SWE provided support to those women who sought to pursue their careers in technical fields, and it continues to provide a strong network that encourages women to achieve their full potential as engineers and leaders. Through events such as Girl Scout Days and through its program development fund, SWE nurtures the growth of the next generation of women engineers [5, 6].

The Association for Women in Science (AWIS) was founded in 1971 to promote women's activities in all scientific fields. This was at the same time of the Women's Rights Movement and the passage in 1972 of the Equal Employment Opportunity Act and Title IX of the Education Amendments. Today AWIS chapters exist in 42 states, and there are more than 5,000 members. AWIS has an explicit commitment to "facilitate networking between women scientists at all levels and in all career paths." AWIS also works to affect national science policy and sponsors educational activities in schools and communities [7].

Thirty years later, however, we see girls' interest and participation in SMET declining by middle school. Sex-role stereotypes, the pressure for conformity in the adolescent peer culture, classroom cultures, and even the nature of the scientific enterprise itself are a few of the barriers identified in the research literature [8, 9]. In the late 1970's and early 1980's, the first Women in Engineering programs began to appear, as either grass-roots or institutionally-sponsored programs, to address these continuing barriers. In 1990, an organization linking these programs was founded: the Women in Engineering Programs and Advocates Network (WEPAN). WEPAN's stated goal is to "effect a positive change in the engineering infrastructure conducive to the academic and professional development of women and men"

[10]. The WEPAN network brings program leaders, faculty and deans, and industry professionals together for a concerted effort to increase recruitment and retention of women in engineering. Annual conferences provide a forum to share experiences and best practices, and WEPAN has produced a program administrator's guide to help new programs get a fast start. The percentage of undergraduate women in engineering has increased from less than 1% in the early to mid-1970's, to approximately 20% today, and WEPAN has played an important role in that success story. At K-State, advice from WEPAN leaders, a WEPAN regional conference, and the administrator's guide all helped in establishing a new program for Women in Engineering and Science (WESP) with strong institutional support, including a substantial operating budget, prime campus space for program offices, and support staff.

These examples illustrate that women have achieved success through supportive networks and the actions of coalitions. They combat the stereotype of the lone, heroic, exceptional woman who succeeds without others. Because of the efforts of previous networks, women now have access to the same educational institutions as men. In response to Title IX, networks involving educators from K-12 through postsecondary are striving to eliminate institutional policies, practices, and cultures that discourage women from pursuing careers in SMET. However, the increased demand for SMET professionals, ushered in by the information age, has demonstrated the continuing need for more effective recruiting of all women and men of color as scientists and engineers. A recent government report details the need for systemic change to meet this increased labor demand [11].

This paper describes one approach to developing a systemic effort to increase the number of women pursuing careers in SMET. It describes the local context in which the program was developed, the infrastructure that shaped the initial planning activities, the process by which broader collaboration was developed, a summary of the evaluations conducted, and the expansion of our network to support work in this area.

LOCAL CONTEXT

Kansas is a conservative state. With a population of a little more than 2.5 million people spread across nearly 82,000 square miles, Kansas needs every resident to contribute to the economic and social concerns of its people. K-State, located in Manhattan, KS, serves a predominantly rural constituency. However, sizable communities lie within an hour's drive, including the capital city, Topeka, to the east and Salina to the west. Even larger urban areas, Wichita and Kansas City, lie within a 3-hour drive.

The participation of women in SMET programs at K-State has improved considerably since the 1950s and mirrors what is seen nationally. At the K-12 level, male dominance on standardized tests has dwindled. Average scores on statewide achievement tests in mathematics at ages

9, 13, and 17 show no gender differences. Among those students who take the SAT, the percent of females who have taken mathematics courses exceeds that of males in courses ranging from algebra to calculus. The only exception is computer math. Course-taking patterns in science demonstrate the increased involvement of females in all fields, most notably physics and chemistry. However, gender differences on statewide achievement tests in science still exist for 13- and 17-year olds. And career goals gathered from the 83 percent of Kansas students who took the ACT in 1999 revealed the persistence of some stereotypes. While men identify engineering as the third most frequently selected career possibility (after the health professions and business), women identify the social sciences and education instead [12].

K-State has had mixed success in attracting undergraduate women into SMET fields. The percentage of majors who are women range from a low of 12 percent in physics to a high of 57 percent in biology. The percentages are a little lower in engineering, ranging from a low of 8 percent in mechanical engineering to a high of 36 percent in biological and agricultural engineering. The presence of women on the faculty is significantly lower, averaging about 12 percent in fields such as biochemistry, physics, and biology but only about five percent in engineering and mathematics.

A number of public school, community-based, and university efforts are directed at increasing the participation of women in SMET. Taken as a whole, these efforts address many of the barriers to women identified in the research and professional literatures. Yet these efforts have produced relatively modest gains in women's participation in SMET at K-State. The authors believe that the network created by the GROW Project can promote the structural changes necessary to welcome Kansas's girls and women into SMET careers.

THE GROW PROJECT

In the fall of 1998, four women faculty and administrators on the K-State campus gathered to plan a response to a call for proposals from the NSF Program for Gender Equity in SMET. Among the options provided, they chose to develop a planning grant that would lead to a full proposal for the large collaborative project option. In the original planning grant proposal, they identified four major program initiatives. Three of those specifically addressed the formation of a network or "collaborative infrastructure" supportive of women's increased participation in SMET. The goals of the planning grant were to identify partners, begin building the network, and conduct a pilot summer workshop for middle school girls, carried out by all members of the network. By the time this proposal was funded, a director for the new Women In Engineering and Science Program was hired and became an active member of the grant steering committee.

Pilot GROW Workshops

The first GROW workshop was held in the summer of 2000, and involved a total of 108 girls who had completed grades 6-8 as of May 2000. Three separate tracks of activities were provided. The "Land" track consisted of outdoor activities either at a nearby reservoir or at the Konza Prairie, a federally-supported research site operated by the Division of Biology. The "Water" track offered a mixture of outdoor and indoor (laboratory) activities, including a tour of the local water treatment plant. The "Living Things" track offered a series of indoor activities at a local science museum as well as campus laboratory activities. Workshop participants were organized into groups of 10-12 girls each, who stayed together throughout the workshop.

Nineteen K-State faculty and staff from nine departments (anatomy and physiology, biology, biochemistry, geology, horticulture, kinesiology, civil engineering, biological and agricultural engineering, and electrical and computing engineering) designed and presented one- to three-hour activities. Sixteen K-State undergraduate women acted as escorts and dormitory chaperones. Five of these women were taking a one-credit hour course on gender-equity issues in science offered by the Women's Studies Program in conjunction with the summer workshop. The other undergraduate women were interested volunteers, some of whom were majoring in SMET fields. Staff members from the regional Girl Scout agency helped plan the workshop, provided some financial assistance, and were instrumental in recruiting girls to participate. School district officials who were involved in various federal programs, such as GEAR-UP, assisted us in recruiting girls from minority populations. Finally, corporate members provided financial assistance to enable girls from low-income families to participate in the workshop.

The network established in connection with the first summer workshop was comprised of 10 entities. These were: K-State faculty and staff; two companies and an industry consortium (Cydex, Kansas City Power & Light, and the Silicon Prairie Technology Association); one school district; two university partners (Haskell Indian Nations University and the Konza Prairie Biological Station), two non-profit organizations (the Girl Scouts of Kaw Valley and the Wonder Workshop), and one city government site (City of Manhattan Water and Wastewater Treatment Facilities). Some partners, like the Girl Scouts and the Wonder Workshop were identified at the time of the planning grant proposal. Others developed out of contacts from steering committee members or from faculty involved. The WESP director's link with an industry connection led to scholarship support from the consortium and its industry members. Faculty members who facilitated workshop activities brought into the network a city agency. The network continues to grow in an organic fashion as each new partner puts us in contact with another set of individuals or organizations interested in the goals of the GROW project.

A second workshop was held in June 2001. Participants were limited to girls who had completed grades 6 and 7 by May 2001. A total of 51 girls participated in a series of science, engineering, laboratory-based, field-based, and community-based activities. The network grew to 16 members: those listed above, plus Grambling University, the Department of Labor Region VII Women's Bureau, HNTB Corporation, GARMIN, the Boeing Company, and Silver Wolf Technologies, Inc. Thirteen of the network members were actively involved in the 2001 workshop. A total of 26 K-State faculty, staff, and students from 12 departments (those listed above plus architectural engineering, entomology, and physics) participated as workshop leaders in the GROW 2001 workshop.

In addition, two women engineers from the Boeing Company donated their time to attend and present workshops, and an African-American male biologist from Grambling University presented a workshop activity. Twenty-two undergraduate women and one undergraduate man acted as escorts, dorm chaperones, van drivers, and assistants for the various workshop activities. The U.S. Department of Labor's Region VII Women's Bureau provided partial financial support for the workshop t-shirts, for the involvement of the faculty member from Grambling University, and for ten girls and one adult to participate in the workshop. The number of corporations providing scholarship support, including the industry consortium, grew to seven.

Pilot Workshop Assessment

Members of the network, as well as the girls themselves, participated in a series of evaluation activities designed to guide the project staff in the development of a longer-term project. Feedback from the girls suggested that they preferred a mixture of indoor and outdoor activities, and that they were as interested in the "life stories" of the female scientists as they were in the nature of the science in which they worked. Workshop sessions that involved the participants in hands-on activities with real-world applications were extremely effective in capturing and sustaining the girls' interest. The first workshop included girls who had completed grades 6-8. This age range proved problematic, as the 8th-graders tended to "silence" the younger students. Therefore, the June 2001 workshop was made available only to girls who had completed grades 6-7.

The use of undergraduate women as escorts as well as the involvement of a substantial number of faculty women as presenters was very well received by the participants. The girls became intensely interested when workshop presenters shared information about their own educational experiences in SMET and the way in which education had prepared them for their current work. In some ways, this information was probably not very different from the information typically available at career fairs and from school counselors. What seemed to make this relevant to middle school girls was that the message was delivered from "real" female scientists and

engineers, and the girls were able to interact with women doing scientific work. The faculty who participated in the workshop activities also were affected by the experience. Many of the women faculty reported that the experience helped them recognize the responsibility they had for increasing the presence of women in SMET fields. Both male and female faculty members who participated commented on the need to counter the natural tendencies of researchers to isolate themselves from the public.

The experience of participating in a course on gender equity in education, serving as escorts for groups of girls who were exploring futures in SMET disciplines, and observing the workshop activities caused many of the undergraduates to reexamine their own abilities in SMET disciplines. Although some of these women were pursuing majors in SMET disciplines, the majority were not. All of the undergraduates who completed the Women's Studies course on gender issues in science teaching reported that they had reexamined their own reactions to these fields – believing that with the right support they could have succeeded in SMET disciplines. This reassessment was an unexpected outcome and was very encouraging. Certainly one of the most formidable barriers to women's involvement in SMET is the sheer number of adult women who truly believe that they are not capable of being successful in science and mathematics. School counselors and teachers alike point out that parent-teacher conferences often start with the parent (often a mother) saying that she was never really very good in mathematics, so she doesn't expect her daughter to be very good either. Parents pass on their own experiences in the form of lower expectations for their children. Revising their assessment of their own experiences in science and mathematics could help many women frame different expectations for their children.

The evaluation results suggested that stronger relationships should be built with neighboring school districts as well as with regional businesses. School districts can assist in recruitment efforts, provide assistance in designing more age-appropriate activities for the workshop, link university efforts to classroom work and educational/career counseling, and provide access to parents. Businesses can provide financial assistance in the form of scholarships that enable many girls to participate in the workshops. However, just as importantly businesses also provide environments in which the girls can see "real" women scientists and engineers engaged in scientific work.

Expansion of the Network and Range of Activities

Between the time of the planning grant and the time we submitted our full proposal, in January of 2001, NSF changed the structure of the PGE program. Projects aimed at K-8 were now to be separate from those aimed at high school and undergraduate levels. We had originally envisioned our network as designed to support women and girls across all levels, and we still believe it can function in this way. However, we prepared our large collaborative

proposal with the explicit goal of developing “a collaborative network of faculty, public school teachers and counselors, and professionals in both private sector/non-profit organizations [who] will deliver and evaluate activities designed to bolster and reinforce the interest of middle school girls in SMET disciplines and careers” [13].

The strength of the network depends on the unique role each partner plays in eliminating barriers to women in SMET as well as the ways in which the partners exchange expertise. Table 1 lists current network members.

TABLE I
GROW P PROJECT NETWORK CURRENT MEMBERS

MEMBERS	CONTRIBUTIONS
Universities/Research Organizations	
BioServe Space Technologies	Personnel
Kansas State University – Main Campus	Personnel & facilities
Kansas State University - Salina	Personnel & facilities
Konza Prairie Biological Station	Personnel & facilities
Haskell Indian Nations University	Personnel
Grambling University	Personnel
Xavier University	Personnel
Corporations/Commercial Organizations	
KCCatalyst (formerly Silicon Prairie Technology Association)	Financial support
Cydex	Financial support
Boeing Company	Financial support, personnel
Kansas City Power & Light	Financial support
Silver Wolf Technologies, Inc.	Financial support
HNTB Corporation	Financial support, tours
GARMIN International, Inc.	Financial support, tours
Hallmark	Tours
Procter & Gamble	Tours
Consolidated Container Corp.	Tours
Dillons	Financial support
Homestead Ranch	Tours
Schools	
3 Unified School Districts in central KS	Recruiting, evaluation data
Non-Profit Organizations	
Girl Scouts of Kaw Valley Council	Recruiting, personnel
Wonder Workshop, Manhattan, KS	Workshop activities
Girls Engaged in Math & Science	Recruiting
Teen Women in Science & Technology	Recruiting
Government	
Environmental Protection Agency	Tours
Dept. of Labor -	Financial support
- Region VII Women’s Bureau	
City of Manhattan Water Facilities	Workshop tours

The strategy to be implemented by network members includes the following components: a hands-on summer workshop, industrial site tours, classroom activities, visits with women scientists and engineers, activities developed in conjunction with commercial and service organizations, and a web site. The project also provides professional development opportunities for middle and high school teachers, such as a graduate-level course on gender equitable teaching methods in science and math classrooms; opportunities to work with K-State faculty to create workshop activities; and action research projects.

The project also provides information for middle school and high school counselors that will assist them in guiding students interested in SMET courses and careers. We have developed a booklet collecting information on SMET

careers, salaries in various SMET disciplines, lists of companies with SMET jobs, myths and facts about women and science, recommendations for high school courses that would be important for SMET majors in college, and a list of resource materials available in print and on the web. The booklet also contains a “conversation” with K-State women SMET students, in which they discuss what was helpful to them in high school, and how teachers and counselors did or did not encourage them. We have distributed this booklet as part of a presentation at a university-sponsored event for counselors and through our school district partners. At the counselor event, the authors were repeatedly asked questions such as: “what kind of girl should we be encouraging to pursue science or engineering?” “what kind of girls are good at mathematics?” and “what characteristics do girls have who would be good at math and science?” We emphasized that there is no inherent quality or “engineering gene” that marks individual girls for success in these fields. We also noted that girls do not have to be brilliant or have exceptional talents to have rewarding careers in SMET fields.

Public schools were not an explicit partner in the planning grant, although a number of school district personnel provided advice and assistance throughout. Public school districts and the university form the K-16 formal educational system through which all students move. Partner school districts have agreed to assist project staff in disseminating information on project activities, recruiting students to participate, and tracking the impact of the project activities on participants. Middle school classroom teachers are linked to university faculty directing various summer workshop activities for the purpose of ensuring that the activities are age appropriate and to explore strategies for integrating continued activities in middle-school classrooms.

Area businesses and corporations were initially involved in the planning grant as financial supporters of either the workshop itself or of individual students in the form of scholarships to attend the workshops. Over the course of the two years, however, it became clear that business and corporate partners had a much more important role to play. Businesses and corporations that employ women as SMET professionals offer opportunities to link successful women with middle school students in an environment in which the content of the SMET fields is well focused. In many respects, their examples of what women in science do is even more tightly connected to the “real” world than university examples. On the other hand, businesses depend on the quality of the students developed through the K-16 educational system and they desire access to the top graduates. The infrastructure being developed will involve area businesses in a much more expanded role. A series of field trips are organized to take middle school girls to business sites that employ women scientists. Women scientists at these sites provide an overview of the various employment opportunities available for women in SMET fields and direct hands-on activities that explore dimensions

of their work. Women undergraduate majors in SMET fields are recruited to act as escorts on these field trips, enabling them to begin to establish personal contacts with potential employers. These escorts also serve as mentors or role models for the middle school girls.

Community groups were an explicit part of the planning activities and have remained a part of the infrastructure being built. These include the area Girl Scouts and the Wonder Workshop. The area Girl Scouts have, from the outset, been an invaluable partner in disseminating information, recruiting participants, and providing financial support for the workshop activities. This enables the Girl Scouts to broaden the range of activities made available to their members. In turn, the university has profited from their advice on how to organize activities of this magnitude for this age group as well as in their ability to capture girls' interest in a non-formal educational setting. Community organizations and services provide yet additional opportunities to link science to societal needs and explore the range of careers possible for those with degrees in SMET fields. These relationships will remain in place, but will be broadened to include similar organizations in communities served by the participating school districts or represented by the partner businesses.

We also have sought to establish a clear identity for the project and our network. One embodiment of that identity has been the development of a logo. We have gathered input for our logo from the girls involved in the workshops and industry tours, from our contacts at the Kansas State University Foundation who help coordinate our work with our corporate partners, and from K-State faculty and staff. The logo is used on our letterhead, brochures, booklets, fliers, other correspondence and on the workshop t-shirts, and is a means by which our partners and the girls who participate in our program instantly recognize activities promoted by this project. The logo is shown in Figure 1.



FIGURE 1
LOGO OF THE GIRLS RESEARCHING OUR WORLD PROJECT

CONCLUSIONS

The network we are building and evaluating, then, involves representatives from the formal and non-formal sectors of education as well as representatives of the educational "pipeline" extending from public schools to university to employment. The goal is to use the linkages within the network to develop more equitable science and mathematics

classrooms in middle and high schools, provide age-appropriate enrichment activities that introduce middle-school girls to women working in SMET fields, and invite undergraduate women and private sector women in SMET fields to become part of a network supportive of girls who want to pursue careers in SMET fields.

During the next three years, the network will be broadened to include interested school districts, community groups, and area businesses. Once in place, the network will be institutionalized within the Women in Engineering and Science Program. We expect to support continued work through a combination of private funding, reallocation of university resources, and public school support. Our intent is that this more systemic network will significantly increase the rate at which women choose to pursue undergraduate degrees in SMET fields.

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