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EXPANDING GIRLS' HORIZONS: STRENGTHENING PERSISTENCE IN THE EARLY MATH AND SCIENCE EDUCATION PIPELINE

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Little longitudinal or follow-up data is available on the impact of Expanding Your Horizons (EYH) conferences. The purpose of the conferences is to encourage girls to take more math and science in high school by exposing them to hands-on activities and role models in math and science professions. This paper is based on 2005 and 2006 one-to-one and small-group interview data from 22 high school girls who attended an EYH conference during their middle school years. The data suggests that EYH strengthens girls' persistence in math and science pathways. Most girls came to the conferences already interested in math and science and at the urging of parents or teachers. Most felt empowered through the shared experience with hundreds of other girls and women, and relayed detailed and enthusiastic descriptions of hands-on activities. Many of the girls also drew connections between EYH and their course-taking actions and career goals. This paper highlights examples of these experiences and makes recommendations for future math and science early pipeline diversity work.

INTRODUCTION

The Expanding Your Horizons (EYH) Conference has been held biennially since 1986 at Humboldt State University in northern California. The purpose of the conference is to encourage girls to take more math and science in high school by exposing them to hands-on activities and role models in science, technology, engineering, and mathematics (STEM) fields. The local conference is sponsored by the American Association of University Women Humboldt Branch and other area organizations and businesses.

The Humboldt EYH conference serves a lower-socioeconomic, rural community that has one of the largest Native American populations in California outside of Los Angeles (Census, 2000). The majority of the girls who have attended the EYH conferences at HSU come from Humboldt and Trinity Counties. Both of these counties are rural northern California communities approximately six driving hours north of San Francisco. The geographic location cuts both of these counties off from many of the resources and opportunities found in other communities that are more connected to urban areas of California.

The Humboldt State University conference is part of a national network of almost 90 sites licensed by the EYH Network formerly known as the Math/Science Network. In 1974 a group of women scientists and educators established the network to address the issues of women's low participation in math courses. The Carnegie Foundation provided early funding for the network, which is housed at Mills College in Oakland, California. In 1982 those involved established the Math/Science Network as an independent nonprofit.

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Since EYH's inception, almost 700,000 girls have participated (Roberts-Ohr, 2006, p. 7). In 2006 there were 89 registered conference sites (EYH, 2006) serving almost 25,000 girls (Roberts-Ohr, 2006, p. 7). Recent EYH annual reports have reported 41% (EYH, 2004) to 63% (EYH, 2005) participation by girls who identified as ethnic minority members. In 2006 almost 3800 workshop leaders participated, along with an average of 17 organizing committee members at each site (Roberts-Ohr, 2006, p. 7).

PERSISTENCE IN THE EARLY MATH AND SCIENCE EDUCATION PIPELINE

While most of the gender gap has been closed in high school math and science course taking (AAUW, 2004; NCES, 2007), these promising high school enrollment practices have not translated into STEM higher education for young women (AAUW, 2001, p. 12). Girls have shifted from a "we can't do it" paradigm to a "we can, but I don't want to" orientation (AAUW, 2000, p. 7). Even though girls perform as well as boys in science and math, there is a marked loss in interest in STEM areas that begins in middle school (AAUW, 1999; Fennema & Sherman, 1978; James & Smith, 1985; White, 1992).

There are many possible causes for this change in interest. Different expectations for girls and boys can lead to gender bias in the classroom (Becker, 1981; Eccles-Parsons, 1984; Gilbert & Taylor, 1991; Kahle, 1990; Wilkinson & Marrett, 1985). Inadequate representation of strong female role models in STEM fields has also been documented as a barrier to girls' interest and participation (Wertheim, 1995). Classrooms across the educational spectrum leave girls and women desiring more practical work that makes connections to problems that are important to them, more autonomy in their studies, and more opportunities for discussing questions and issues (Catsambis, 1994; Osborne, Simon, & Collins, 2003; Seymour & Hewitt, 1997). The absence of these types of experiences in math and science classrooms sends them searching elsewhere for majors and careers.

There have been many programmatic efforts to strengthen persistence in math and science course taking and the related career pathways (Yanowitz & Vanderpool, 2004) . While some have found linkages between pipeline persistence and participation in extended experiential programs for elementary and high school students (Atwater, Colson, & Simpson, 1999; Hammrich, Richardson, & Livingston, 2000), others have suggested that single-day programs may be particularly well-suited for attracting and maintaining middle school students in the early STEM pipeline (Yanowitz & Vanderpool, 2004). Limited longitudinal and follow-up studies examining the one-day Expanding Your Horizons (EYH) conferences provide some evidence that program participation influences interest and the related persistence in the early math and science pipeline.

The EYH Network asks conference organizers to collect and report on attendee demographics and attitudinal data regarding workshops, speakers, and conference organization. These evaluations are overwhelmingly positive. Most of the girls report that they loved the day, increased their affinity for math and science, and, at least on that day of the conference, planned to take more math and science in the future (Cortez-Regan & Virnoche, 2007; Roberts-Ohr & Spencer, 2006; Thompson & Virnoche, 2003).

Yet, immediate evaluations as described above offer little insight into lasting influences of EYH. Like many programs designed to effect social change, there has been little follow-up data collected on long-term program-related outcomes. According to

the EYH Network, to date there have been two follow-up EYH studies and one longitudinal evaluation.

The EYH Network in 2002 conducted the most recent follow-up study. The EYH Network partnered with the Center for History and Media Echo Project at George Mason University to collect national data on EYH alumnae (Spencer 2006 personal communication). The Center established Echo in 2001 to offer free consultation in launching history of science and technology web sites. ECHO continued in 2006 to host the online alumnae survey for the EYH Network.

As of January 2006, 54 participants had been solicited through announcements and networking via professional organizations. Articles about EYH and the survey were published in the newsletters of several women-in-science organizations, as well as National Organization of Women (NOW) newsletters. Announcements were also made at science conferences and the survey was linked to the EYH Network Web site (Spencer 2006 personal communication). Along with demographic and contact information, the survey solicited data on a combination of seven closed- and open-ended questions regarding participation in EYH, education, and career experiences.

Most (81%) had positive or very positive reactions to EYH. Most (87%) had math- or science-related majors in college. Almost half (48%) reported a moderate to strong influence from EYH on their undergraduate major. Along with EYH, participants also discussed the influence of teachers or other unrelated mentors and parents or other family members (Roberts-Ohr & Spencer, 2006, p. 5).

Although the results are positive, they must be considered with caution. First, recruitment of respondents was heaviest in science organizations. So it would be expected that those EYH alumnae responding would report having become scientists. And while they reported the influences of EYH on their decisions, our interpretation of those influences cannot be generalized to the EYH alumnae population. The participants were not randomly selected for participation, they represent only a fraction of EYH alumnae, and it is possible that self-selection bias created a sample of women who were influenced by EYH and wanted to share that experience with the EYH Network.

The study does tell us that some women who are EYH alumnae understand EYH as central to their life experiences of math and science and their career paths. It is also interesting and significant to note the clarity with which some respondents position EYH in their life experiences. This detail in their memory would seem to reinforce the importance of the event in their lives.

An earlier longitudinal study supported by the National Science Foundation considered outcomes for seventh to twelfth grade attendees at six 1981 San Francisco Bay Area EYH conferences (Davis & Humphreys, 1985). Researchers collected pre- and postconference data from girls on the day of the conference. Six months later, a stratified random sample (n = 389) completed follow-up questionnaires. With a response rate of 67%, the 261 follow-up surveys were matched with conference day surveys for analysis.

Overall, Davis and Humphreys found that conference participation created an increased interest in nontraditional careers and increased the number of math classes that girls expected to take. Six months later, the girls reported taking even more math than they thought they would by the end of the EYH conference. The girls had also taken a number of actions to learn more about nontraditional careers: they talked to

parents, worked in science-related jobs, and found information at the library. Davis and Humphreys (1985) concluded that these conferences were an effective and inexpensive intervention. Yet, without a comparison sample of girls who did not attend EYH, one cannot be certain the postconference actions reported by the girls can be attributed to their EYH participation.

As Davis and Humphreys (1985) suggest with their qualitative data, the conference may serve as a significant forum to help girls maintain their interest in math and science, and resist the pressures to follow more stereotypically feminine career paths. Students reported that workshop leaders helped "shatter" stereotypes of scientists and helped them "withstand social pressures" (p. 96).

A third study by Tomhave (1990) addressed many sampling issues common to program evaluation studies by taking advantage of a naturally occurring quasi-experimental design. She compared three groups of girls (n = 225) who were in junior high school in 1982: girls who did not intend to participate in an 1982 EYH conference ("nonintended"), girls who intended to participate and were "present," and girls who intended to participate but were "absent" due to a snowstorm.

As one might expect, the girls who intended to participate in EYH, whether they were present or absent, reported liking math and science more than the girls who never intended to participate. By using the absent girls as a control group, Tomhave was then able to control for any possible effects of this original difference in interest. In other words, the Tomhave study would suggest that it was indeed the EYH program itself, and *not* attendee predisposition to science and math, that changed long-term outcomes. Tomhave also controlled for possible effects of town size and distance, as well as course availability.

Tomhave (1990) found in 1990, eight years after the conference, that those who attended EYH reported taking significantly more years of math classes in high school than either the absent or nonintended groups. In general, girls from all three groups ended up taking more math (specifically trigonometry) than they thought they would in 1982, suggesting that junior high girls probably do not understand a high school curriculum well enough to predict their own behavior with accuracy. Yet, in 1990, EYH attendees were more likely to have taken trigonometry than the absent or nonintended groups.

Although those who attended EYH took more years of science than the nonintended group, this difference could not be attributed with certainty to EYH attendance: there was no significant difference in the years of science taken between EYH present and absent groups. Looking specifically at physics, 50% of EYH attendees enrolled compared to 35% and 30% of absent and nonintended girls, respectively (Tomhave, 1990, p. 27). While Tomhave reports that these differences were not statistically significant ($p < .094$), the 15–20% gain in physics enrollment for the EYH present group suggests substantive significance: Tomhave's inability to find statistical significance is partly an artifact of her relatively small sample size.

By 1990, past EYH participants were the most likely to retain plans for earning a professional or doctoral degree. Yet plans for earning an advanced degree had decreased in all groups: women in all three groups were less likely in 1990 than they were in 1982 to express plans for an advanced degree. This would indicate that EYH had some effect on the advanced-degree plans of its participants. Still, very few women in

any of the groups had chosen career paths that required "much" math and science and *there were no differences in career types of the groups.*

Of the past EYH participants, more than half reported that EYH had positively influenced them in some way, including encouraging their interest in math and science (Tomhave, 1990, p. 46). The patterns reported above would indicate that EYH influences high school course taking and subsequent levels of higher education; yet, retained interest in math and science careers may require additional interventions. By 1990, all three groups of women had developed similar levels of interest in math and science.

STUDY PURPOSE AND CONTEXT

This article is part of a larger study in which we asked, "How do high school girls make decisions about course taking and career planning?" In this article, I specifically consider girls' memories of EYH and their perceptions of how participation in EYH influenced their high school course taking and career anticipation. Course taking and career anticipation are important factors in early pipeline persistence. As a follow-up study of the 2001 and 2003 Humboldt conference for middle school girls, this piece contributes to the limited literature on long-term influences of EYH participation, as well as the larger theoretical literature regarding early STEM pipeline persistence.

This report was written at a time when the Humboldt AAUW branch and EYH conference organizers were considering, in lieu of EYH, the sponsorship of a different intervention model such as "Tech Trek." The Tech Trek model had become popular because it structured several days of science and math immersion in a "camp" format that was perceived to better strengthen persistence. Yet, the Tech Trek model averaged a cost of $500 for each girl compared to the $20 average for HSU EYH participants. The high costs of the more extensive model combined with travel distances for girls living in remote areas of northern California led organizers to be concerned that fewer girls would be served. It was in this context of both evaluating EYH outcomes and planning for future STEM diversity work in northern California that this study was launched.

METHOD

This report is based on semistructured interviews with 22 high school girls who had participated while in middle school in a 2001 or 2003 Humboldt State University Expanding Your Horizons Conference. Between May 2005 and May 2006, nine of the girls completed individual interviews and 13 took part in five small group interviews. At the time of the interviews, two to five years had passed since they attended EYH. To maintain confidentiality, I altered position titles and assigned pseudonyms to girls and the participating schools.

The Research Team

Ten university women and two high school girls contributed to the design and implementation of this research study. The choice of an all-women team was intentional.

Given the underlying issue that precipitated this study, namely, the scarce numbers of women participating in STEM fields, it was critical that women and girls have the opportunity to do the (social) science of this project. In addition, it was important that data collection be conducted by women for methodological reasons discussed below.

Four female graduate research assistants in the Master's in Practicing Sociology Program at Humboldt State University were central to the team. They helped coordinate much of the data collection, facilitated many interviews, and contributed to the data analysis. Six undergraduate sociology majors also participated in the study. Supervised by myself and/or a graduate research assistant, they conducted most of the phone interviews. All the research assistants were in their twenties and could have "passed" as high school students.

Working with high school counselors in the first months of the study, I found two high school girls who were willing to help us. We met and talked about our study ideas, securing participation, and the logistics of interviewing their peers. They also introduced us to life in their high schools and helped us understand how our study might or might not work.

Two female faculty members, one from sociology and one from engineering, were also involved in the project. Our engineering faculty member, Beth Eschenbach, was the director of the Humboldt State University Expanding Your Horizons Conference. This program was the focal point for this evaluation study. She contributed to the study by providing past conference records, keeping us abreast of changes in the field, and making presentations related to our study. She was also a resource on the literature related to girls' and women's participation in STEM fields. As the team's lead sociologist and research director, I coordinated the overall project and am ultimately responsible for the decisions that were made.

Sampling Method

HSU conference years 2001 and 2003 preregistered 582 girls from 63 elementary schools in northern California. We researched the transfer patterns between these elementary schools and high schools in the region and determined that most of these girls were likely attending one of 14 public high schools in the area.

In choosing high schools to work with in this study, we took several factors into consideration. First, because of broader interests in matriculating Native American students into HSU STEM majors, we wanted this study to include Native American students. Second, we anticipated complex coordination needs with partnering schools that would be facilitated by face-to-face meetings. In addition, because of the strengths of qualitative methodologies for providing a nuanced understanding of attitudinal and decision processes and the scarcity of this methodology in this literature (Osborne et al., 2003), we planned for face-to-face qualitative interviews with the girls. Given these goals, the geographic dispersion of high schools, and limited resources, we selected schools that both met travel restraints and offered us potential access to the greatest number of EYH past participants.

In the end, the schools that participated included two high schools with the largest Native American enrollments and a third high school with the second-largest number of past participants. The school with the largest number of participants had declined

participation. The partnering schools accounted for 28% (165) of the names on our lists. After high school staff reviewed the lists, they confirmed enrollment of 101 of the girls at their schools. It is likely that girls not confirmed at the expected high schools moved away, were attending private or charter schools, or attended other high schools because of the work locations of their parents.

Study information packets were delivered to the girls through our high school contacts at Big Bear and Bayview High Schools and by U.S. mail for Oceanview girls. Each envelope contained a cover letter from the school contact, two copies of a letter to parents or guardians that doubled as a consent form, and a flyer designed to catch the girl's attention. The flyer highlighted the incentives for participation, including free food and drinks, a party, and a raffle for a computer and other prizes. Bayview and Big Bear girls received two to three solicitations including personal meetings with school staff members. They were also asked to return their consent forms to the school office. We provided Oceanview girls with stamped return envelopes. The differences in contact and consent processes were requirements made by the school staff.

Sample Description

The 22 girls attended one of three high schools in northern California: Oceanview, Bayview, and Big Bear. Oceanview and Bayview were fairly large schools for this area of the state, enrolling 800–1800 students, and served predominantly white student populations. Big Bear was a smaller school, enrolling less than 300 students, and served a majority of Native American students.

Three of the girls who participated were Native American, one girl identified as Native American and Mexican American, and the other 18 girls were white. The girls identified family members in middle to lower social classes (Lindsey & Beach, 2004), discussing construction work, teaching, and other professions as areas of employment for their parents. While most of the participants reported attending one of the 2001 or 2003 conferences, several girls reported attending both.

Ultimately, 22% of the 101 past EYH participants that we contacted turned in permission forms and followed through with an interview. EYH registration materials did not collect ethnicity information linked to names for the 2001 and 2003 conferences attendees. And due to educational privacy restrictions, the high school contacts could not release information on any girls on our EYH participant lists. Therefore, I cannot report whether the response rates of nonwhite girls were any different from those of white girls.

Small Group and Individual Interviews

Graduate research assistants sorted the parental consent forms by school, EYH status, and ethnicity, and organized groups accordingly. For the small group interviews, the graduate research assistants contacted each girl by phone, spoke to her briefly about the study, and asked her to participate in a group discussion or a one-to-one interview. A series of phone calls were usually needed to coordinate a meeting time. All girls received a follow-up reminder call one to two days before the interview.

These interviews were, in most cases, conducted after school in available classrooms or other meetings spaces. We usually provided drinks and snacks. In all group

discussions, we asked girls to read and sign assent forms that stated that the girls were to keep confidential the discussions of their peers. In a few cases, we did one-to-one interviews at a quiet local restaurant.

The undergraduate researchers conducted the phone interviews later in the project with girls who could did not participate in the face-to-face interviews because of scheduling conflicts or because they had forgotten to come. The team gathered in the early evenings and called lists of girls. They either conducted the interview immediately or tried to schedule another time for the call. They improvised their introductions based on a general script encouraging the high school girls to find a quiet place in their homes where they could talk openly and without distractions. They used structured interview guides (Table 1) that I adjusted based on data from earlier small group interviews. Digital audiorecordings of all interviews were captured, transcribed, and entered into NVivo for analysis. In most cases, the interviewer transcribed her own interviews, facilitating the recall and notation of additional nonverbal elements of the interview.

Power, Teen-Adult, and Cross-Race Interviewing

Much of the literature on children as research participants takes up the issue of power differences between the researcher and the participant. The adult/child relationship implicitly contains a power differential, given the structure of our society. This relationship coupled with ethnic differences and the power differences in the researcher/participant relationship may impede the interview conversation.

Many strategies have been suggested to address the power issues around teen interviewing. Eder and Fingerson (2002) discuss the advantages of small groups of peers, teens as facilitators or cofacilitators in the interview process, and the use of interview staff closer in age to the participants. Similarly, same-ethnicity and same-gender interviewing can be helpful in talking with nonwhite girls (Dunbar, Rodriguez, & Parker, 2002; Ryen, 2002). In general, other researchers have addressed power issues through a feminist approach to interviewing that rests on a more interactive style that incorporates interviewer self-disclosure (Harding, 1987; Nielsen, 1990; Reinharz, 1992).

We considered all these suggestions and scheduled small group discussions when possible. We conducted one-to-one interviews when there was only one student in a

Table 1. Interview Guide Central Themes

1. Demographics
2. General course (then math and science course) selection processes and influences
3. Resistance to the system
4. Job or career aspirations and influences
5. Images and their influences (math and science)
6. (EYH) memories of conference
7. (EYH) reasons for attending
8. (EYH) message(s) of the conference
9. (EYH) influences on course taking (career aspirations)

racial group, if the other students who were scheduled for a focus group did not show up, or when other scheduling demands required it.

We considered involving high school girls as facilitators. Yet, the high school girl research team members themselves felt that some of their peers might be "less likely" to disclose experiences to them because of the social constraints of the high school hierarchies and cliques systems. Also, since one of our high school research team members was white, we felt that the cross-race interviewing would be better if the white interviewer was from outside the high school. Given these insights, as well as logistical constraints of scheduling small group discussion times, we chose to have the academic research staff facilitate the interviews.

For the most part, the research team agreed that the interviews themselves went well. Most of the girls seemed very comfortable sharing their high school experiences. They were often animated in the description of their experiences. Jokes and laughter were common. There were, of course, some girls who were quieter than others and required the facilitator to work harder to draw them into the discussion. The team was coached in feminist methodology that encourages sharing. Therefore, research team members shared their own stories of high school math and science and college as they encouraged participants to retain their interest.

Data Analysis

The digital recordings of interviews were downloaded and stored. Research assistants used Express Scribe, a freeware product, to play and transcribe the recordings into word processing files. The transcriptions were then imported into NVivo, a qualitative data-analysis program.

During the course of collecting interview data, the research team discussed themes that they heard in the interviews. I kept notes and reviewed transcripts as they became available. I developed an initial coding process (Charmaz, 2002; Strauss & Corbin, 1990) based on these discussions and review of the transcripts. As a graduate student and I returned to the transcripts multiple times, we expanded coding themes and then developed a focused coding process (Charmaz, 2002; Strauss & Corbin, 1990) that addressed questions germane to this article. Interviews were also coded to allow for analysis based on demographic data.

Limitations and Challenges

The recruitment barriers that we faced were complicated by privacy and student data concerns and policies. Working through school principals in two school cases, we were linked with school counselors and office staff members who became our main contacts for the project. On directions from the principals, school staff members were the only ones allowed to see student names and distribute information to the girls.

Although our response rate for past EYH participants (22%) was not as high as we would have liked, it is respectable, given the warnings we received about the challenges outsiders would face recruiting high school girls for interviews on math and science. And although the findings are not generalizable, the narratives offer nuanced insights into a range of experiences and longitudinal outcomes of EYH participants.

PARTICIPATING IN EXPANDING YOUR HORIZONS: INFLUENCES AND OUTCOMES

Coming to the EYH Experience

Walking through the heavy metal doorway of the West Gymnasium was just the beginning of the EYH experience. Yet, arriving at this place was not a simple process. Most of the girls perceived a great deal of self-direction in their arrival at EYH: they attended EYH because they were already interested in math and science and they wanted to be with friends or escape their rural communities. Yet, structural factors including mentoring and transportation were key enablers for many girls. Strikingly absent from the narratives of Native American girls, as well as the white girls from the predominantly Native American school, was any discussion of parent involvement. For them, teacher mentoring was critical for EYH attendance.

Relying on Individual Agency. All the girls talked about some element of-self direction and decision making that brought them to the doors of EYH. Although almost all the girls had anticipated that the conference would be interesting, girls from the more remote high school discussed additional incentives. In one Big Bear focus group, the girls talked about their geographic isolation. They agreed that they participated in many programs such as EYH in order to get away from their rural community and to be with friends. Their memories of EYH had become interwoven with many other visits to Humboldt State University. Collectively, they constructed and reconstructed the "right memory," correcting one another so as to focus everyone's memories on the EYH conference. Field trips and programs that took them to larger cities and onto college campuses offered a break from school and the limited entertainment venues in their own communities. And while one girl speculated that she and others likely went to these types of events because friends were going, they all remembered that the bus had physically gotten them to EYH.

Structuring Participation. While the girls perceived a largely self-directed path to EYH, they also discussed structural factors that facilitated their participation. Like girls who attended other EYH conferences (Roberts-Ohr & Spencer, 2006), our EYH alumni reported that mentoring of parents and teachers was important. While almost all the girls talked about teachers, several of the white girls from the predominantly white high schools said that their mothers facilitated their EYH attendance. And in this study, the rural girls also pointed to the significance of organized bus transportation.

The parental mentoring narratives were similar to those in Kendra's story. She was a white junior taking AP math classes and was torn between college studies in dance and marine biology. As other white girls reported, Kendra's mother was active in her educational planning. Her parents established a college fund. Her mother enlisted the help of a friend at UCLA to assist Kendra with college planning. Kendra's mother "scouts and looks for things" that will help Kendra with her education. EYH was part of that scouting. Kendra talked about how hard her parents worked to give her the best chance for college. She wanted to make them proud of her.

The type of involvement and parenting that Kendra describes has been noted by others (Lareau, 2003) as typical of "upper-middle-class parenting." This form of inten-

sive parenting is in part a function of time, class expectations, and resource availability. All the girls who identified as Native American, as well as the white girls from Big Bear, talked about teacher rather than parental mentoring. Although the social class location of the Big Bear focus group students was unclear, most students at Big Bear come from economically struggling families. And all responded emphatically that it was "the bus" that was central to their attendance at EYH. One Oceanview girl who identified as Native American was clearly middle class. Her father was a biologist who influenced her general interests in science. Yet, even she noted that it was a teacher who influenced her EYH attendance.

Quantitative data comparing EYH 2003 and 2005 data for the rural Big Bear high school suggests an interaction between intensive teacher involvement and transportation (Cortez-Regan & Virnoche, 2007; Thompson & Virnoche, 2003). In 2003, a Big Bear teacher worked actively with EYH organizers, and EYH provided bus transportation. It was a record year for Big Bear EYH attendance. In 2005, intensive teacher involvement was absent. Although a bus was offered, a school counselor communicating with EYH organizers said that it was not needed. That year far fewer Big Bear girls attended EYH.

Constructing EYH Math and Science

EYH had been empowering for most of the girls. They retained detailed, positive memories based on collective experiences and individual accomplishments in hands-on workshops. Although the exception, two girls were disappointed with their workshops. They recalled working on math exercises that felt too much like high school. Again the exception, two other girls had no memory of participating in the conference.

Generating Girl Power. The collective experience coupled with hands-on activities was empowering and built the girls' confidence. Most of the girls retained detailed and pleasant memories two to five years after participating in EYH. This level of recall was similar to that found by Roberts-Ohr and Spencer (2006) in their study of past EYH attendees.

Several of the girls said that it was amazing just entering a gymnasium filled with other girls and women who they assumed liked and/or were good at math and science. Even as they relayed the experience now as a memory, faces were bright and eyes big as they said it was just very "cool."

When asked to recall their activities, many took the interviewer step by step through the day, as well as the particular workshops that she had attended. Cheryl had just completed her sophomore year at Oceanview high school when we interviewed her. She was one of the four participating EYH alumnae who identified as Native American. Her father had been a biologist and was a significant force in shaping her career interests. Cheryl wanted to be a veterinarian or at least "work in that field." She described her two years of EYH hands-on activities with enthusiasm as follows:

> I remember that onion DNA experiment. I wanted to do the cloning of a plant, but I never got to do it. There was a bird beak and we learned about the food they ate—why the birds had the beaks they did. I aced that one. I remember the astronaut coming, and getting a lot of brochures....

Cheryl continued with other details of her day. She also told us that she remembers following up on her EYH experience with additional Internet research of her own. She was particularly intrigued by the astronaut who spoke, and she was encouraged to "check out" satellites that orbited the earth.

Recreating School and Losing Opportunities. The two Native American girls in the Big Bear group, Natalie and Talia, offered the clearest memory in their group at EYH. While the other girls in their group were still trying to figure out which of their experiences had been EYH, Natalie and Talia clearly co-constructed their EYH day. They described the campus, the gym, the science fair booths, and the workshops that they attended. They reported attending a workshop where they were given a piece of paper and they "learned math stuff." Both agreed that it felt "like school" and was not much fun.

We never learned the career paths of these girls because they left the interview quickly. When pressed about her current school experience as she packed her bags, one girl tearfully suggested that she could not get the types of more challenging classes that she needed and was going to have to transfer to a different high school. She clearly had plans for higher education and was worried about her work at Big Bear.

The experience of EYH as yet another negative school experience presents a significant missed opportunity. Natalie and Talia managed to pass through the many barriers of interest and access to EYH only to end up in a workshop that replicated negative experiences of math they encounter in the schools. Although many of the EYH activities are very engaging, all workshop leaders are volunteers and there is little control over the content of their workshops. While conference organizers coach workshop leaders on pedagogy strategies, only after the fact, via workshop evaluations, do we discover volunteers who delivered problematic workshops.

Envisioning Careers in Math and Science

For the most part, the girls relayed limited and shallow understandings of math and science professions. They constructed their images from observations of common service providers such as doctors, discussions with relatives who worked in STEM fields, and popular culture. Because of these limited avenues for learning about professions, girls told us that it was good to talk with EYH volunteers about their jobs and how they got there. Workshops and informal discussions with conference volunteers working or studying in STEM fields provided rare glimpses into professional worlds that were hidden from most of the girls. Although a few girls credited EYH with their current STEM career path, others suggested that their early post-EYH enthusiasm for math and science careers had waned.

Sparking and Sustaining Career Interests. For a number of girls, the EYH experience "sparked" their interest in fields they knew little about. For others, it presented an opportunity to find out more details about the experiences of workshop leaders working in fields that had already captured their attention.

Cheryl, as a Native American raised mostly among white people, saw images of white men when she thought about math and science. She had had only one woman as a science teacher. Although she knew that women could be mathematicians and scientists, EYH helped that image become more "real" and she said,

> It reminded me of it…I knew, but it started to get into my subconscious a little more. I could get more actual pictures of a female scientist from that….

For Cheryl, EYH served to reinforce her interests in science, while sparking her interests in a new career path. One of the EYH workshops encouraged her to think about her own career aspirations and gave her a new perspective on a veterinary career:

> I met a traveling vet who went around in her van all day. That was cool and shut my fear (of an office job) out. She showed us how to do the stitch on the stuffed cat and gave us the needle. She talked about what she did instead of being a regular vet. She talked about the dogs she'd saved. I never thought a vet could go around in a van. That was way out there and I'd never thought about it. I knew there were wildlife parks, but I never thought there would be a vet like that.

Cheryl's story of a peek into "a day in the life of a traveling vet" is an example of the significance of shared career narratives and paths at EYH conferences. She had never considered that a veterinarian could work outside a typical animal medical office. For her, the career narrative of the traveling vet opened new ways of thinking about future studies and career paths.

In addition to new career ideas, girls also discussed the significance of EYH for reinforcing existing interests in various careers. Two white girls from Bayview, Bianca and Rachel, were already tracked for advanced science and math course taking when they attended EYH. Both were hoping to get into top universities, and were doing everything they could to make that happen. They both liked math more than science and agreed that math was just fun, but that you couldn't really use math to "do" anything unless it was combined with science. Although Bianca had an already established theater career and planned to continue that pursuit into college, she planned to minor in math "for fun." Even for math lovers like Bianca, EYH and other programs are challenged to uncover career applications for math education.

Rachael was most interested in astronomy, though she continued to change her mind. She recalled the influences of EYH on her career aspirations:

> I think the most important thing was that it sparked my interest more in astronomy. That's where I heard what engineering was and what it means. I'm still kind of interested in that. I don't know if I want to be an engineer, but that field and that research was introduced.

Rachael had also since had an opportunity to visit an astronomy lab at UC Davis that was very interesting for her. As noted above, she and Bianca were advanced students and very goal oriented. Both recognized the heavy involvement of their parents in their decision making. Rachael's mother had attended EYH with her. EYH became a pro-STEM "repeater" in a network of career signals—many of which urge girls to do anything but stick with math and science.

Losing Interest in Math and Science. Several girls reported a dissipating effect of EYH on career interests as high school experiences took over. They reported being

bored or not being "good enough," a common theme in other studies that examine the relationship between gender and the math and science pipeline leakage (Seymour & Hewitt, 1997). Still others reported that they felt competent, but like the reports from other girls (AAUW, 2000), they just didn't want to study math and science.

Heidi was a white senior from Oceanview whose parents had completed some college. When she began her interview, she had given up thinking about herself as a scientist despite five years of math and four years of high school science. She said:

> I remember back then I was really interested in [science] and I thought I might want to be a doctor or a scientist. For a while I wanted to do genetics research. I think high school changed that for me since I thought I wasn't as good at science or math. When you think you're not good in something, you can't really have a career in it.

When pressed by the interviewer on her self-evaluation of not being "good enough," Heidi reflected self-consciously on how she came to that conclusion. For her, it was clear that if others were finishing assignments faster than her with, fewer questions, then the field was not a good choice for her. Heidi felt there should be a synergy between what came easy to a person and their chosen profession.

Yet Heidi was not a bad student. She had been accepted to a prestigious east coast university and planned to begin study there in fall 2006. Her high school math and science classes had taught Heidi that math and science were for people that liked to problem solve for single solutions: "There's one answer. So if you say something and you have the wrong answer...." Heidi believed that people like her, who liked to look at problems and ideas from multiple perspectives, were better suited for majors like comparative literature. "I think you just like something or you don't. [I] don't know why."

Denise was a Bayview junior who identifies as white. She was awed by and doing well in both math and science at the time of the conference. Her science teacher encouraged her to attend EYH with her mom. After the conference, she thought she would become a marine biologist.

Later, Denise's a high school science teacher said that marine biology required "a lot" of math. Denise did well in math and science, scoring in the ninety-eighth percentile on her STAR test and was taking four years of college placement (CP) or advanced placement (AP) math and science. Yet, in high school math bored her. Denise had abandoned her marine biology aspirations to avoid taking more math classes. At the time of the interview, she planned to become a high school English teacher or a social worker so that she could "help kids."

The effects of EYH had not only worn off for Heidi, Denise, and others, in some cases it felt more like their enthusiasm had been sucked away. Denise could not imagine continuing with more boring math to reach her career goal of marine biology. Heidi no longer thought genetics was a good choice for her because of comparisons with peers and the sense that math and science did not have room for creativity. Perhaps because the researcher questioned her reasoning, or perhaps because the interview helped her recall early positive experiences of science, by the end of the interview Heidi defiantly stated, "I think in college I will give math and science another chance. I can't let what happened in high school dictate everything else." To that extent, the interview itself

may have been an additional intervention that helped girls like Heidi reconsider further math and science education.

Getting the Message, "Take More Math and Science..."

The take-home message of EYH was, "Take more math and science in high school so you have more options later in life." Although many girls felt that EYH reinforced their interests in taking math and science courses, some girls said that EYH had little effect or they were uncertain if it had affected their course taking. Some said that EYH influenced the types of math and science courses that they chose. EYH also generated a seriousness with which they approached the study of math and science, and created expectations and excitement for lab study in high school.

Teri, an Oceanview white junior, recalled perfectly the message of the conference. She also drew clear connections between that conference experience and her experiences in math and science afterward. It not only influenced her course taking, but also the degree of attention she paid, particularly within her science classes:

> It made me really interested in science...so I really paid attention, especially in eighth grade science. It was really hard and I had Mr. H., who was a very strict teacher, but it made me...in both seventh and eighth grade science, made me want to learn as much as I could and get good grades because they pushed learning math and science to get into college. They said, "Science and math is superimportant. You can use it in everyday life and whatever career." And they had so many different careers, and they said, "Whatever you decide to do, you're going to be needing science and math."

Teri maintained this frame of thought despite even recent counterarguments from her own mother, who had had a poor experience in biology:

> My mom asked me the other day why I was taking biology and I said, "You can use Bio in whatever you do." And she said, "I'm sorry but I haven't used Biology since I got out of the class in high school." Whatever. She also had a very bad experience when she was in biology in high school and she came into the class and there was a male teacher. And he said, "I know that the boys are going to do better than the girls in this class because guys are better at science than girls are." So my mom stood up and said, "Then I'm not in this class" and got a different biology teacher.

Thus, for students like Teri, EYH had been important to her ability to mitigate the negative messages about science from her mother. As can be seen in other narratives of EYH alumnae, there are many sources for math and science discouragement. Now in high school, the girls who remained interested in math and science reported high-level math courses with few girls compared to boys. Their classroom experiences too often did not live up to the excitement of EYH. Still, the EYH experience and enthusiasm has played a role, at least for some participants, in maintaining enthusiasm for math and science course taking.

DISCUSSION AND RECOMMENDATIONS

This paper focuses on 2005 and 2006 one-to-one and small group interview data from 22 high school girls who attended an EYH conference during their middle school years. The girls came to the conference with the urging of parents, teachers, and counselors. They were drawn to the conference because they were interested in science and/or math and wanted to escape boredom and/or to be with their friends.

While a few of the girls could not recall the EYH experience, most of the girls relayed detailed descriptions of their day. Several of the girls shared feelings of empowerment as they experienced being in a gymnasium with hundreds of girls and women who liked math and science. Most reported being engaged by hands-on workshop activities, but at least two girls experienced workshops that felt (boring) like school.

The conference provided the girls an opportunity to get a better sense of STEM careers and the women who study and work in them. These insights were significant to the girls who knew little about STEM fields beyond service occupations such as doctors and nurses. Some of the girls made connections between their EYH experiences and their course-taking actions and career goals. Others just felt that the experience reinforced their existing interests and plans for study and career. Since course taking and career anticipation are important early STEM pipeline persistence measures, results indicate that conference participation contributed to pipeline persistence.

Overall, girls reported that EYH did have an influence on how they felt about themselves, their path of study, and their careers (Table 2). Yet these influences in some cases were fleeting as girls negotiated the many social messages from peers, teachers, family, and the media. Based on this follow-up study, recommendations for future EYH and other similar programs are as follows:

1. *Get teachers engaged with conference recruiting,* since they are especially important for involving rural, lower-income girls, as was the case for the Big Bear girls. Release time provided by budgeting for substitute teachers may be the most effective method to structure the involvement of already busy middle school teachers (Virnoche & Lessem, 2006). It would be especially helpful to identify these teachers at rural and predominantly lower-income schools, where parent involvement is less likely and there does not easily develop a critical mass of peers to facilitate attendance.
2. *Identify effective workshop leaders* using conference evaluation data. Invite them back, and discontinue workshops that are ineffective. Emphasize to new workshop leaders the importance of *quality* hands-on experiences (Mathison, Wachowiak, & Feldman, 2007; Owens & Foos, 2007), providing examples from other EYH workshops. These actions will help avoid the "lost opportunity," such as in the cases of Natalie and Talia who experienced yet another "boring" encounter with math.
3. *Workshop leaders should explain their career paths and a sense of their complex identities as partners, mothers, and community volunteers.* Some of the girls wavering from STEM paths offered their desire for a family as a reason for opting out of the pipeline. As leaders share more about their work and outside interests, they will add depth to the girls understanding of STEM careers and the wom-

Table 2. Summary of Influences and Outcomes for EYH Participants

1. Coming to the EYH experience
    - Relying on individual agency (field interest, escape, join friends)
    - Structuring participation (parent/teacher mentoring, transportation)
2. Constructing math and science at EYH
    - Generating girl power (collective experience, hands on)
    - Recreating school and losing opportunities (pedagogy style important)
3. Envisioning careers in math and science
    - Sparking and sustaining career interests (new ideas and details, making it real)
    - Losing interest in math and science (not good enough, boring)
4. Getting the message, "Take more math and science...."

en who study and work in them. Others have suggested that it is important to share both the contributions made and challenges faced by women in STEM fields (Martin, 1996).

4. *Workshop leaders should emphasize the creativity needed in solving complex problems with math and science.* In this study, Heidi and others articulated a perceived mismatch between themselves and a STEM pathway. They enjoyed creative problem solving perceived as absent from math and science and their experiences of "one answer" textbook problems.
5. *Develop and coordinate a multifaceted regional plan* to encourage early STEM pipeline persistence. The positive impact of the EYH concept is caught in a stream of pipeline detractors (Parrott, Spatig, Kusimo, Carter, & Keyes, 2000). The girls in this study articulated multiple messages that discouraged their persistence. These messages came from parents, teachers, and classroom experiences of math and science. Coordinated efforts with teacher education programs, career planning initiatives, and workshops like EYH will bolster the multiple sources that support persistence.
6. *Provide women role models in STEM.* Likewise, high schools need to hire women science and math teachers. Although girls may indeed intellectually understand that women are STEM professionals (Eisenhart, 1994), girls like Cheryl told us that getting to know the women workshop leaders and volunteers made the idea more "real."
7. *Offer workshops for parents, teachers, and counselors* to help them envision a wider set of futures for girls, while educating them on the challenges that girls will face (Parrott et al., 2000). As girls in this study expressed, after the conference these groups of people continued to be important in supporting or detracting from their persistence in math and science.

In addition, it is central that we continue follow-up and longitudinal studies of EYH and similar programs to better evaluate their efficacy for social change and STEM

persistence. Social change that diversifies STEM professionals will also diversify tomorrow's physical, technological, and intellectual landscape.

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