Summaries of Research Presented by the Social Science Advisory Board

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Parents as Learning and Production Partners: Links to Teens' Interest and Experience with Technological Fluency Building Activities

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Topic/research question

Examination of the "digital divide" has increasingly gone beyond the study of differences in physical access to computers to focus on individuals' use of technological tools for empowered and generative uses. To address issues of equity involving participation in new media activities, there is a need to go beyond a focus on access to tools to begin to more deeply theorize the nature of supportive learning resources (Warschauer, 2000; Barron, 2004; Barron, Walter, Martin, & Schatz, 2009). In this presentation, findings from two studies of parent-child learning partner relationships will be reported.

Overview of research methods used & findings from Study 1

The first study used qualitative methods to obtain rich first-person accounts from highly engaged adolescents and their parents (Barron et al., 2009). The results of the first study indicated that the general category of coactivity has many forms that are usefully distinguished. Seven parent roles that were instrumental for children's learning and project work were reliably categorized: teaching, collaborating on projects with, providing nontechnical support to, brokering learning opportunities for, providing learning resources for, learning from, and employing children to assist with technical projects. Each role was instrumental for learning, although their form and function varied. Although the Teacher and Collaborator roles provided the most direct opportunity for parents to scaffold their child's knowledge and engagement through face-to-face interactions, the Learning Broker role was equally powerful when it connected a child with people or experiences that could support learning. The Nontechnical Consultant role supported engagement and offered assistance that furthered a child's project, and the Resource Provider role procured the physical tools of production or resources from which a child could learn. The Employer and Learner roles gave the adolescents a chance to be more expert and put their knowledge into practice. These roles can be viewed with a broader eye to what they offer the child beyond content knowledge. For example, parents' values and implicit hopes for their child play out in these roles (Lareau, 2003). The Learning Broker role provided several examples of powerful socialization experiences where parents connected their child with a person, place, or experience.

Overview of research methods used & findings from Study 2

Results from the first study were used to create a set of survey items that could be administered to larger samples. The second study used quantitative methods to explore the relationship between adolescent's expertise and parents' support. A sample of 350 eighth graders in Silicon Valley completed the survey. The results confirmed positive relationships

between the range of parent roles and depth of adolescents' experience with production activities. In addition, a positive relationship was found between the range of ways a parent served as a learning partner and their use of technology in their work. The frequency of the type of role also varied with the degree of technology use by parents in the context of work. This result was replicated with a sample of African American 8th graders living in Chicago.

Intended use

These results will be discussed with respect to a broader framework that conceptualizes a learning ecology as the "activities, material resources, and relationships that are found in co-located physical or virtual spaces that provide opportunities for learning" (Barron, 2004; 2006). The findings are relevant for parents, teachers, and other stakeholders who are interested in supporting the development of new media literacy and identities as able users of new technologies. One paper has been published (Barron, et al., 2009) and another one is in preparation.

References

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Understanding Women's Performance and Persistence in IT

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Topic/research question

The NSF-funded project "Commonwealth Alliance for Information Technology Education-CAITE" (Rick Adrion - PI) aims to increase access to higher education and the innovation economy for those currently economically, educationally and socially disadvantaged – groups that include substantial numbers of women and minorities. In order to track the Alliance's success in increasing the participation of women and minorities in Information Technology we have tracked institutional trends in IT enrollment and retention from all participating schools.

Overview of research methods used/to be used

We have built a wealth of data regarding the gender and racial/ethnic mix of students entering, transferring into, exiting, and graduating from IT fields as well as their performance in IT courses since the year 2000. Initially, we intended for this data to be informative of general trends and patterns emerging from each school demonstrating the effectiveness of CAITE in increasing participation amongst targeted groups. However, interesting patterns have emerged from our review of the baseline data (2000-2007) that warrant further study.

Preliminary findings

The data has shown that women outperform their male peers (have higher GPAs) in IT courses in all of our schools although they have low-levels of persistence in the field. This paradox between performance and persistence has led us to question whether we should broaden our means and/or moment of intervention. There is a subset of women that are in IT courses that do well but are leaving and we are unsure at this moment when (after one course or more) and why (does performance matter).

Intended use

Our interventions have been focused on exposure and increasing awareness of IT to women and underrepresented minorities, but unraveling the paradox of performance and persistence may lead us to implement new interventions to further support students who are interested in IT so that their initial interest is sustained.

Changing the Image of Computing to Increase Female Participation

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Topic/research question

In this research, I propose that current stereotypes of computer scientists interfere with women's ability to see themselves in the field. Accordingly, the proposed research tests the efficacy of transforming social environments to encourage diversity of membership. Several controlled behavioral studies focus on how stereotypes of the field may discourage participation. The proposed work brings together three disparate research areas – the media, environments, and peers – into one theoretical model. Rather than testing a single explanatory path to explain the link between stereotypes and career aspirations, the proposed research examines several mediating processes (e.g., stereotype threat, social fit) to find the strongest one while also allowing for the possibility of multiple mediators. This work is funded by an NSF CAREER award.

Overview of research methods used/to be used

Several behavioral experiments were conducted at Stanford, the University of Washington, and the University of Georgia to elucidate the relationship between stereotypes of computer science and women's interest in entering the field.

Preliminary findings

We found that women, but not men, were less interested in working in companies and taking classes that contained objects stereotypically associated with computer science (e.g., Star Trek poster, video games) compared to identical companies and classes that had non-stereotypical objects (e.g., nature poster, general interest books). The stereotypical cues evoked a masculinity that made women feel that they did not fit with the people in these environments. These results held even when the proportion of women in the environment was equal across the two types of companies.

Intended use

Cheryan, S., Plaut, V.C., Davies, P., & Steele, C.M. (2009). Ambient belonging: How stereotypical environments impact gender participation in computer science. *Journal of Personality and Social Psychology, 97,* 1045-1060.

Cheryan, S. & Plaut, V.C. (in press). Explaining underrepresentation: A theory of precluded interest. *Sex Roles*.

Gender and Computing Conference Papers

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Topic/research question

We know that diversity of thought produces better and faster solutions to complex problems (Page, 2007). For this reason, and other practical and ethical reasons, the computing disciplines strive to improve women's representation in the field (Cohoon & Aspray, 2006). These efforts often concentrate on piquing the interest of young girls and college students, but they less often attend to women's engagement as leaders and problem solvers. This paper addresses one aspect of the latter topics by measuring trends and influences on women's authorship of computing conference papers.

Overview of research methods used/to be used

Data from over 3000 ACM-affiliated conferences, workshops, symposia and forums held between 1966 and 2009 provide evidence of women's increasing contribution to this form of professional engagement and contribution to computing. Using custom software called Genderyzer1 (Kaye, 2009), we identified the gender for 90% of the 356,703 authors who presented at ACM events between 1966 and 2009[2].

Preliminary findings

The data show that women's authorship increased substantially over time, and that relative to their representation in the likely pool of ACM conference paper authors, women Ph.D.s were especially productive. Initial tests indicate that the increase in women's share of papers was due in large part to the increase in the number of women in the community of potential authors. Variation in women's authorship across conferences was associated with conference topic and paper acceptance rates.

Intended use

Our findings contribute to knowledge about the conditions that promote gender diversity in this important aspect of the discipline's intellectual life.

This paper has been submitted to the Communications of the ACM and is under review.

1 http://genderyzer.com Created by author Kaye while a student at Cornell University and an employee of Nokia.
2 Details on software accuracy, which we believe to be the first tests of such accuracy, are provided in the methods section of this paper.

Stolen Promise: The Making and Unmaking of Girls in Engineering

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University of Colorado at Boulder

Topic/research question

In Fall 2006, our NSF research team identified 131 10th grade girls with strong academic records in mathematics and science at 7 high schools in 3 states (Colorado, Iowa, and Ohio) and invited them to participate in an after-school program to explore career possibilities in engineering. These girls became part of the FREE project ("Female Recruits Explore Engineering"). The girls included Latinas, African-Americans, and Native Americans (mostly), with some Asians and Whites; many of the girls lived in families that qualify for free or reduced lunch at school; although they were all strong students in science and math, few had considered engineering as a college or career choice. From early 2007 through August 2008, we met monthly with these girls to explore engineering, meet practicing engineers, visit engineering workplaces, discuss the pros and cons of engineering, and conduct hands-on engineering--all in an effort to increase the girls' knowledge of and interest in engineering.

We are addressing the following research questions: What is important for high school girls to know about engineering and how do they find out about it? How does the prospect of a career in engineering fit into the social contexts of the girls' lives? How do the girls' racial, socio-economic, and rural/urban locations influence their perspectives on engineering? And, how and why do young women's interests in engineering change over time?

Overview of research methods used/to be used

We used multiple methods of data collection: participant observation to record what happened during the monthly meetings; interview questions posted on the website about the girls' developing ideas of engineering; surveys about the girls' previous experiences with engineering and technologies, school performance, future plans, and social networks. We captured girls' website postings and electronic messages from Blackberries that we distributed to the girls as an incentive for their participation.

Preliminary findings

We found that it was not hard to get the girls interested in engineering. A year and a half after the start of FREE, 30% of the original group was considering majoring in engineering in college. This percentage held steady through most of the girls' senior year (i.e., almost 3 years after FREE began). Apparently, high school was not too late to spark both minority and majority girls' interest in engineering. Hesitant at first, those who stayed in FREE found time, energy, and money to visit college engineering programs, get to know engineering professionals, identify engineering projects of interest to them, and complete their own small-scale engineering projects.

But by the time the girls actually entered college (Fall 2009), only 22% of those who continued in FREE (11% of the original group) chose an engineering major; 35% chose another STEM major[3],[4]; and 33% chose a non-STEM major.[5] What turned out to be a barrier for many of the girls was not the prospect of doing engineering itself but the challenges of *getting into* a college with an engineering program and actually (physically) *getting to* a college with an engineering program. The challenges seemed to come, in large part, from a lack of economic, social, and cultural capital (access to economic, social, and cultural resources) to make the transition from high school to college engineering. The CO group, with the least access to capital, had the most trouble (only 4% of the original group actually chose an engineering major); the IA group, with somewhat more access to capital, did better (13%); and the OH group, with the most access to capital, did best (30%).

Intended use

For more information, see our website: http://xploreengineering.org

[3] For our purposes STEM includes: biological sciences (including medical), physical sciences including physics, chemistry, astronomy and materials sciences; mathematics; computer and information sciences; geosciences; engineering; and technology areas associated with the preceding fields.
[4] Some of these girls began FREE with an interest in science or math, but most did not.
[5] Others were "undeclared" in Fall 09 or did not attend college.

Women and Men Faculty in Academic Science and Engineering:
Social-Organizational Indicators and Implications

Mary Frank Fox
Georgia Institute of Technology

Topic/research question

This article depicts four key social-organizational features of work, as reported by women and men faculty in science and engineering: frequency of speaking with faculty in home unit about research; ratings of aspects of position and department; characterizations of departmental climates; and levels of interference experienced with work and family. The article points to a) the ways in which these key features of work are consequential for status in academic science and engineering; b) the ways in which experiences with these features vary for women and men faculty; and c) the ways that institutional practices and policies, reflecting these features, may be improved toward greater gender equity.

Overview of research methods

Survey of women and men faculty in doctoral-granting departments in computer science, engineering, and science fields in nine highly ranked research universities.

Findings

First, women are less likely than men to speak daily about research and more likely than men to report speaking less than weekly. Second and related, women give significantly lower rankings to aspects of their position/unit, signifying lower benefits of human and material resources in vital areas: access to equipment, sense of inclusion from faculty in department, and recognition received from faculty for their accomplishments. Third, the characterizations that women, compared to men, give to their home units support the idea that academic units do not operate uniformly. Fourth, levels of work-family interference are notable, and women report higher interference than men, especially of family on work (compared to work on family).

Publication

Fox, M.F. (2010.). Women and men faculty in academic science and engineering: Social-organizational indicators and implications. *American Behavioral Scientist, 53*, 997-1012.

Improving Transfer Access to STEM Bachelor's Degrees at Hispanic Serving Institutions through the America COMPETES Act

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University of Southern California

Topic/research question

This NSF-funded study examined institutional characteristics that support transfer from a community college to the STEM baccalaureate for Hispanic students, and the ways in which Latinos use community college attendance as a pathway to obtaining a bachelor's degree in STEM. The study connects the goal of increasing the number of underrepresented minorities in the sciences and engineering with the current national policy dialogue on improving successful outcomes in higher education.

Overview of research methods used/to be used

Data came from analyses of IPEDS (1997-2007) and NSF 2003 NSRCG data, as well as of the likely impact of the America COMPETES Act on Hispanic Serving Institutions (HSI).

Preliminary findings

The America COMPETES Act authorized by Congress in 2007 directs the National Science Foundation to develop an HSI Undergraduate Initiative, with the goal of increasing Latina and Latino degree completion in STEM fields. Appropriations through this act substantially increase NSF's budget in traditional funding areas such as teacher preparation, research fellowships and scholarships, and laboratory facilities. Funds are also allocated to build HSI capacity via curriculum development, experiential learning, and program evaluation.

This report highlights the role of HSIs in producing a greater share of Latino students who earn degrees in computer science, mathematics, and engineering, than do their counterparts at non-HSIs. However, Latino students who transferred from community colleges to HSIs had lower rates of participation in these fields of study. Given the large number of Latinos in community colleges, transfer access to these fields must be increased in order to produce more Latino STEM baccalaureates.

Intended use

Dowd, A.C., Malcom, L.E., & Macias, E.E. (2010). Improving transfer access to STEM bachelor's degrees at Hispanic Serving Institutions through the America COMPETES Act. Los Angeles, CA: University of Southern California.

Developing New Strategies for Using Title IX with STEM and Warming Up the Climate for Women in STEM

Bernice R. Sandler
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Title IX: Apart from the use of Title IX in filing complaints with the federal Education Department and/or in individual and class action lawsuits, Title IX can be used in a number of less drastic ways which are possibly more effective and less traumatic in developing change. For example, here are a few examples of how gathering information can play an important role in effecting change.

Developing information in particular institutions and/or departments to assess patterns may indicate deliberate or unintended sex discrimination against students (including prospective students), faculty and staff. The collection of such data often increases awareness of the status of women in STEM, identifies specific trends and problem areas, and often leads to many recommendations which can ultimately make a difference.

Another area is *how to make change happen in STEM*. All too often recommendations are developed and nothing happens. What does it take to bring about a new policy or program? What strategies are useful? How do you involve other people? How can you become a "mover" and a "shaker?"

The Chilly Climate: Often women (and others who are "outsiders") are treated differently by men and women alike, in ways that can diminish women's confidence, self-esteem, participation, and ambitions. Most people are unaware of these behaviors and thus do not notice when these behaviors are aimed at women, nor do many women themselves recognize that these behaviors have even occurred.

I have identified about 50 ways in which this occurs, such as not calling on women as often in classes or meetings, asking men more "critical thinking" questions while asking women factual questions instead, calling women by name less often, giving women less eye contact, giving women less feedback, praise and criticism, etc. I have developed numerous strategies in which women (and others) can respond when these behaviors occur to them.

Additionally, the evaluation of women is often flawed and problematic. The unconscious devaluation of women affects hiring interviews and subsequent decisions involving women and their professional careers. Fortunately, strategies exist to increase the awareness of the devaluation of women (and others) and to ensure that evaluation procedures and decisions can be more fair. My work has been focusing on what particular strategies might be utilized.

High School Physics Experiences, Physics Identity, and Gender

Gerhard Sonnert
Harvard University

Topic/research question

The NSF-funded project "Persistence Research in Science and Engineering" (PRiSE) investigates which high school science experiences contribute to students'—and especially female students'—interest in a STEM career. One of our major hypotheses is that the development (or non-development) of a science identity during the high school years is an important determinant of interest in a STEM career. This presentation examines what predicts the formation of a physics identity.

Overview of research methods used/to be used

The main data source of the PRiSE project is a nationally representative sample of college students in English composition classes (N~7,000). The students completed a comprehensive questionnaire about their high school science experiences and other background variables.

Preliminary findings

We identified several significant predictors of a physics identity, among them high school physics courses focusing on conceptual understanding; labs addressing beliefs about world; courses having discussions of currently relevant science; the student making comments or answering questions in class; and the student teaching classmates. Female scientist guest speakers in high school physics classes had no effect on the women students' physics identity. By contrast, discussions in class about the underrepresentation of women in science were associated with an elevated physics identity among the female students.

Intended use

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*.

Computing Self-efficacy and Mathematics Competency among Women in India

Roli Varma
University of New Mexico

Topic/research question

The NSF-funded proposal "Cross-National Differences in Women's Participation in Computer Science Education between India and the United States" investigated the following two research problems: (1) Why are women in India attracted to CS education? (2) Does female attraction to (or rejection of) CS study vary differentially between India and the United States? One of the findings is that female students entering universities in the U.S. underestimated their abilities in math and, thus, in CS. In contrast, even though female students had no exposure to computers in India, they had little anxiety about CS because they considered themselves very strong in math and logical thinking. This presentation examined women's self-efficacy in CS in India and its relationship to mathematics.

Overview of research methods used/to be used

Data for this presentation came from in-depth interviews that were conducted with 60 female undergraduates majoring in CS in India in 2007−2008. The study took place on two engineering institutes and two universities that granted four-year undergraduate degrees in CS.

Preliminary findings

This case study shows that socioeconomic context must be taken into consideration to understand how gender intersects with CS and mathematics. Because they perform well in mathematics, female students in India have high self-efficacy for learning new content of CS. The new domain of CS builds on prior skills of mathematics. This suggests that CS and mathematics share skills. There is a need to do a comparative study of mathematics teaching to girls and boys in the United States and India to understand issues related to gender and mathematics.

Intended use

Varma, R. (forthcoming). Computing self-efficacy among women in India. *Journal of Women and Minorities in Science and Engineering*.

Computational Agency Development among Refugee Girls

Sneha Veeragoudar Harrell
TERC

Topic/research question

The STEM Agency Initiative bridges the gap between knowledge acquisition and dispositions+identity development by:

1. Identifying and characterizing relations among computational knowledge, skills acquisition, normative discourse practices, and identities as computational learners and practitioners, including dispositions and self-image.

2. Conducting an empirical investigation of how computational agency develops and a critical investigation of the fostering agency model through implementation in a setting for at-risk students from underrepresented groups.

3. Developing standards-aligned materials, activities, and facilitations for fostering computational agency.

Overview of research methods used/to be used

This year long critical ethnography/design-based research study centered around 2 month long interventions and a series of interviews, field trips, and public presentations. Student participants are recent refugee girls from a wide range of countries including Tanzania, Iran, Kenya, Iraq, Sudan, Afghanistan, Eritrea, Burma, Somalia, Zimbabwe and others. All students are English Language Learners. Raw data consist of: digital video of class sessions, individual semi-clinical interviews with a subset of focal students, ongoing interviews with the teachers and school director; field notes and participant-generated mixed-media artifacts. Case studies focuses on individual students development of skills and dispositions over time constructing narratives through identifying key episodes and conducting micro-genetic analysis.

Intended use

Veeragoudar Harrell, S. (under review, 2010). STEM Agency Initiative: Teenage Refugees Finding Voice through Computer Sciences. In P. Allison (Chair), *STEM Knowledge and Education Across Boundaries: Ruptures and Consolidation of Social Structures in Science and Mathematics Education.* Paper submitted for presentation at the Annual Meeting of the American Anthropology Association, New Orleans, LA.

Veeragoudar Harrell, S. (2010, May). *The STEM Agency Initiative: Institutionalizing Critical Pedagogy Practices*. Paper presented at the annual meeting of the American Educational Research Association, Denver, CO, May 1, 2010.