FINAL REPORT FOR AWARD # 0305859

Indiana University
ITWF: Toward Gender Equitable Outcomes in IT Higher Education: Beyond Computer Science

Individual Participants:
Co-Principal Investigators: Manju K. Ahuja; Susan C. Herring; Christine L. Ogan
Graduate students: Julie Estell; Debbie Goh; Kristin Hanks; James A. Marken; Helen Robinson; Sharon Stoerger; Eren Tatari
Undergraduate students: Chelsea Dzaugis; Dana Tulekbayera

Participants' Detail

Partner Organizations:

SUNY at Buffalo: In-kind Support

The School of Informatics, Management and Systems Department, and Computer Science and Engineering Department at this university participated in the study. Their contributions included allowing us to survey students online, conduct phone interviews with faculty and staff, and meet in person with students and representatives of the units. Faculty and staff also assisted us in gathering information regarding their units. Some units assisted us in the process of applying for approval from their University's human subjects committee, as well.

SUNY at Buffalo dissolved their School of Informatics in the summer of 2006. However, individuals who had been affiliated with that program were given the opportunity to continue their participation in this study.

University of Illinois at Urbana-Champaign: In-kind Support

The Department of Computer Science and Graduate School of Library and Information Science at this university participated in the study; their contributions included allowing us to survey students online, conduct phone interviews with faculty and staff, and meet in person with students and representatives of the units. Faculty and staff also assisted us in gathering information regarding their units.

University of Michigan Ann Arbor: In-kind Support

The Department of Electrical Engineering and Computer Science and the School of Information at this university participated in the study; their contributions included allowing us to survey students online, conduct phone interviews with faculty and staff, and meet in person with students and representatives of the units. Faculty and staff also assisted us in gathering information regarding their units and assisted us in the process of applying for approval from their University's human subjects committee.

University of Michigan Dearborn: In-kind Support

The Performance Improvement and Instructional Design Program at this university participated in the study; its contributions included allowing us to survey students online, conduct phone interviews with faculty and staff, and meet in person with students and representatives of the unit. Faculty and staff also assisted us in gathering information regarding the unit and assisted us in the process of applying for approval from the University's human subjects committee.

This program was disbanded after completion of the first round of face-to-face interviews.

University of Washington: In-kind Support

The Information School, Technology Management MBA Program, Educational Communication and Technology Program, and Computer Science and Engineering Department at this university participated in the study. Their contributions included allowing us to survey students online, conduct phone interviews with faculty and staff, and meet in person with students and representatives of the units. Faculty and staff also assisted us in gathering information regarding their units.

Other collaborators:

NONE

Activities and findings:

Research and Education Activities:

This ITWF project investigated 18 tertiary education programs in information science, information systems, instructional systems technology, and informatics, with computer science programs as a baseline comparison, in five major public IT degree-granting institutions. The universities were: Indiana University Bloomington, State University of New York at Buffalo, University of Illinois at Urbana/Champaign, University of Michigan at Ann Arbor and Dearborn, and University of Washington. These institutions were selected based on the minimum requirement of having a computer science unit and at least two other IT-related units. We also gave preference to institutions with programs in instructional technology and/or informatics, as these are relatively less common.

The primary purpose of the study was to determine which universities, departments, and programs were most successful at recruiting and retaining female students, and what factors favored female success over time. The programs were hypothesized to be differentially welcoming to female students due to differences in academic culture—operationalized in terms of the availability of mentorship, role models, peer support networks, grant programs, and other resources at departmental, university, and disciplinary levels. These measures

of organizational culture were related to self-reports of student experiences as collected through a web survey and in-depth oral interviews conducted at three one-year intervals. Our study thus involved a systematic, large-scale investigation of the role of academic culture in relation to women's IT educational experiences over time.

In the initial phase of the project, we collected data about student experiences through a web-based survey of more than 1,700 male and female undergraduate and graduate student majors in the 18 participating units. We developed the survey to measure students' experiences within their programs and to determine what led them to develop an interest in IT higher education. The survey was conducted in March and April 2004 by the Center for Survey Research (CSR) at Indiana University. Most students were contacted directly by CSR through their university email accounts. Students in three units were contacted through an administrator in their unit via email, out of a concern by those units to protect student privacy. The survey respondents answered 100 questions related to their attitudes and behaviors regarding use of computers, demographic information, and information about mentoring, stress, and burnout.

We received 1,768 responses to the survey. Of the 1,506 respondents who indicated their gender, 589 (39%) were female and 917 (61%) were male. The distribution of the respondents, broken down by academic discipline and gender, is as follows:

Computer Science=620 (F=115, M=505)
Informatics=180 (F=73, M=107)
Instructional Systems Technology=149 (F=77, M=72)
Library and Information Science=433 (F=290, M=143)
Management Information Systems=124 (F=34, M=90)

In the second phase, we conducted a telephone survey with faculty, administrators, and staff in the same 18 units. The telephone survey was a 45-minute in-depth questionnaire asking about faculty and staff experiences, programming for students, perceptions of student experiences, mentoring, and other issues posited to be relevant to the creation of a woman-friendly climate in IT departments. The telephone survey was administered during Fall 2004 by the Center for Survey Research (CSR) at Indiana University. A total of 280 tenure-track faculty and administrative staff participated (56% faculty, 31% administrators); of the participants, 112 (40%) were female and 168 (60%) were male. The distribution of the participants, broken down by academic discipline and gender, is as follows:

Computer Science=99 (F=27, M=72)
Informatics=36 (F=13, M=23)
Instructional Systems Technology=36 (F=21, M=15)
Library and Information Science=77 (F=40, M=37)
Management Information Systems=32 (F=11, M=21)

Our focus in the third phase was on collecting data through oral interviews with selected students from the 18 participating units. The interviews were conducted in three rounds one year apart between spring 2005 and spring 2007. The first two rounds were conducted face-to-face on the participating institutions' campuses, and the third round was conducted by telephone. The interviews lasted approximately one hour, and interviewees were compensated for their time with a $35.00 gift card to Border's Books and Music. The

interview consisted of between 20 and 50 questions, depending on the round, focusing on how the interviewees perceived their programs and their experiences in those programs. Subjects were asked about their computing ability and use, student/faculty relationships, their mentoring experience, about any incident(s) where they'd felt valued or been made uncomfortable, whether or not they felt successful in their programs, and to what they attributed their ability to be successful. Subjects were also asked a series of questions on gender, such as why, in their opinion, there were more men than women in IT fields, and whether or not they thought that men would have an easier time in their programs.

The interview candidates were originally to have been selected from the web survey pool; however, this method proved to be insufficient for several reasons. Many of the undergraduates who took the web survey were seniors who then graduated, or juniors who were seniors the following year, whereas we had hoped to target sophomores and juniors. In addition, some institutions contacted the students through group mailings rather than allowing us to contact them individually, so in those cases, we had no way of knowing who exactly took the survey. Thus we could not directly invite those survey respondents to be interviewed. We therefore adjusted our recruitment techniques to include asking interviewees to nominate or bring along friends who fit our target demographics, and asking professors to nominate potential candidates. We also attended classes during our on-campus visits and made announcements inviting student participation.

In all, we conducted 317 interviews with 168 individuals, 109 females (65%) and 59 males (35%). Since the focus of our research was on the experiences of women in IT-related disciplines, we aimed to over-sample for female interviewees at a ratio of 2:1. However, we did not meet this target in all cases, since there were so few women in some of the units. Undergraduate women majoring in Management Information Systems were especially difficult to find. In order to have samples of roughly equal size from each academic level, we also over-sampled for undergraduates at a ratio of 2:1, since the IT units in the study had fewer undergraduate than graduate programs.

Round 1 Interviews

Round 1 interviews were conducted face-to-face by an Asian-American male graduate student in Instructional Technology at Indiana University who was a Research Associate for the project. Each interview lasted 40 to 60 minutes, and immediately after, the interviewer took field notes describing his impressions of the participants and their responses. A total of 152 face-to-face interviews were conducted, 136 of them with students (the remainder were with faculty). Eighty-seven female and 49 male students were interviewed. Demographically, the student interview breakdown for round 1 was as follows:

Discipline:
Computer Science=56 (F=37, M=19)
Informatics=15 (F=9, M=6)
Information School/School of Information=9 (F=7, M=2)
Instructional Technology=15 (F=10, M=5)
Library and Information Science=15 (F=10, M=5)
Management Information Systems=26 (F=14, M=12)

Level:

Undergraduate=47 (F=28, M=19)
Master=47 (F=31, M=16)
Ph.D.=42 (F=28, M=14)

In addition to these interviews, we also conducted classroom observations and made ethnographic observations of the physical spaces of the various units during the on-site visits.

The last of the on-site visits for round 1 was completed in April 2005. The summer was spent transcribing the interviews and continuing with the analysis of the data from the phone and web surveys conducted in the first phase of the study. The transcribed interviews were then coded and analyzed using the N6 qualitative research software. The N6 coding was finished in late September 2005.

Round 2 Interviews

Recruitment procedures for the round 2 interviews were similar to those followed in round 1. The primary difference was that participants from round 1, rather than those who completed the web survey, were contacted via email to schedule on-campus interviews. In the event that an interview candidate did not respond or was not available, attempts were made to locate new contacts via email to recruit additional participants. Because the program was disbanded, individuals representing the Performance Improvement and Instructional Design (PIID) program at the University of Michigan at Dearborn were not included in the second and third rounds of interviews.

The interview process in round 2 was similar to round 1. The same male graduate student was the interviewer; interviews were conducted face-to-face and lasted 40 to 60 minutes; and the interview consisted of approximately 50 questions (not all were asked of every interviewee) focusing once again on how the interviewees perceived their program, as well as their specific experience in the program. In total, 118 students were interviewed in round 2, 82 females (69%) and 36 males (31%). Demographically, the student interview breakdown for round 2 was as follows:

Discipline:
Computer Science=41 (F=31, M=10)
Informatics=14 (F=8, M=6)
Information School/School of Information=21 (F=15, M=6)
Instructional Technology=13 (F=9, M=4)
Library and Information Science=5 (F=4, M=1)
Management Information Systems=24 (F=15, M=9)

Level:
Undergraduate=34 (F=22, M=12)
Master =40 (F=30, M=10)
Ph.D.=44 (F=30, M=14)

The round 2 interviews were completed in spring 2006, and the transcription process was completed and all of the transcribed files were uploaded into N6 by the end of June 2006. In the process of analyzing the results, new coding categories were added. A comparative

summary of the results of the round 1 and round 2 interviews that included normalized percentage calculations was also created at that time.

Also in Spring 2006, we attempted to expand the number of institutions participating in the study. The discipline of Computer Science was by far the largest single discipline represented. In an attempt to balance the disciplines, we collected Web survey data from students in the Information Systems department at Georgia State University, using SurveyMonkey. We opened the survey on March 31, 2006; the last response was collected May 27, 2007. Fifth-nine GSU students took the survey, of whom 36 indicated their gender. We also approached the Information Sciences and Technology college at Pennsylvania State University, but they declined to participate in the study.

Round 3 Interviews

The third and final round of interviews was conducted by telephone. The first set of invitations was sent via email beginning in February 2007 to individuals who participated in round 2. As many as two follow-up emails were sent to each individual who did not respond to the earlier invitations. In cases where individuals did not respond, the appropriate school directories were searched, and searches of Google, MySpace, and Facebook were also carried out in an attempt to locate alternative email addresses. Even though the University at Buffalo took steps to dissolve their School of Informatics in the summer of 2006, individuals who had been affiliated with that program were given the opportunity to participate in the round 3 interviews.

The interviews were conducted by a female American graduate student in Information Science at Indiana University, who was a Research Assistant for the project. The interview consisted of approximately 20 questions focusing on the interviewees' experiences in and overall level of satisfaction with the program; each interview lasted on average between 20-40 minutes. Field notes that summarized impressions about the interviewees, as well as key points that were revealed during the course of the interview, were written during and immediately after the interviews.

Sixty-three students were interviewed in round 3, 46 females (73%) and 17 males (27%). Demographically, the student interview breakdown was as follows:

Discipline:
Computer Science=22 (F=15, M=7)
Informatics=5 (F=4, M=1)
Information School/School of Information=15 (F=10, M=5)
Instructional Technology=10 (F=8, M=2)
Library and Information Science=0 (F=0, M=0)
Management Information Systems=8 (F=6, M=2)

Level:
Undergraduate=8 (F=5, M=3)
Master's=21 (F=15, M=6)
Ph.D.=31 (F=23, M=8)

The last round 3 interview was conducted in April 2007. The transcribed interviews were coded and analyzed using the N6 qualitative research software, and the results were added to the summary of results for rounds 1 and 2.

While the interviews were being conducted, transcribed, and analyzed, statistical analysis of the results of the web and telephone surveys were conducted using SPSS. Content analysis was used to analyze the open-ended questions on the surveys. A graduate student assistant also conducted a content analysis of the websites of the 18 study units, focusing on gender representation.

Research dissemination workshop:

Throughout the summer of 2007, we were actively involved in planning activities for a workshop to disseminate the results of, and best practices deriving from, the findings of our data collection and analysis. The workshop was held from September 28-30, 2007 at Indiana University, Bloomington. Approximately 50 individuals from the participating research universities, as well people from outside institutions with an interest in gender equity in IT education, attended the workshop. (See Outreach for further details regarding the research dissemination workshop.)

Based on feedback from the participants, we created a Google Groups forum as a way to continue the conversations that began at the workshop. One of the participants also invited us to add our workshop materials to the Computer Science Teachers Association (CSTA) Repository site (http://csta.acm.org/WebRepository/WebRepository.html).

Findings:

Highlights from the findings of analysis of each of the three main datasets are presented below.

--The Web Survey--

Some demographic differences were evident prima facie between the computer science (CS) and applied fields. Specifically, the CS students tended to follow a more linear academic path, going from undergraduate straight into master's programs and then (occasionally) on to Ph.D. programs. The applied students, in contrast, tended to be older and to have work experience; many of them were returning to academia for degrees to enhance their professional careers. Since there were many more men than women in CS in our sample, and more women than men in some of the applied fields (especially Library and Information Science and Instructional Systems Technology), this demographic distribution is important to keep in mind in interpreting the survey results.

An overall trend was that students in some of the disciplines we surveyed tended to give answers that correlated with one another. LIS and IST tended to pattern together, as did CS and MIS, with Informatics falling in between. For example, students in MIS and CS were more likely to indicate that career was more important, and students in LIS and IST were more likely to say that their personal lives mattered more. Another interesting pattern was that men in traditionally male disciplines tended to pattern together with women in

traditionally female disciplines, and women in traditionally male disciplines patterned together with men in traditionally female disciplines. For example, CS men and LIS/IST women were disproportionately likely to indicate that they were 'very satisfied' with their major, and MIS men and LIS/IST women were more likely to say that their values were 'very similar' to those of their field.

Gender differences were also found that cut across age and discipline. Women in both CS and applied IT reported having less confidence working with computers than did the men. Men in both groups began using computers and learning to program at young ages and on their own more often than the women did. In adolescence, women in CS used computers for communicating and men for games. Women in the applied IT disciplines said that helping others was important in their choice of major more often than did male IT majors. Overall, these results support the findings of previous studies for women in both CS and applied IT disciplines.

One finding that points to a need for further study involves the relationship between mentoring and self-efficacy with computers. Somewhat problematically, women with women mentors showed lower self-efficacy not only compared to women with male mentors, but also compared to both male and female students with no mentors at all. Given the low numbers of female students who had exclusively female mentors, it is best to treat this result with caution. Some explanations suggest themselves, such as that even as faculty members, women continue to be less connected and powerful (and thus less effective as mentors) than men. Alternatively, it could simply be that stereotypical images of women being less able with IT color women's perceptions of their women mentors. More heartening, the amount of mentoring a student receives was found to be a significant predictor of self-efficacy (other significant predictors were sex of student and time spent on computers as a teenager), suggesting that women can be helped to greater self-efficacy through increased mentoring.

--The Phone Survey--

Faculty and staff perceived students at every level (undergraduate, Master's, Ph.D.) as being concerned about employment once they graduate; they also saw students as being concerned about whether they were acquiring the right skill sets. The largest category of concern that the faculty attributed to their students relates to classes and curriculum (when faculty were given a chance to respond in an open-ended manner, issues of class/curriculum ended up being the largest category). Faculty especially believed that students were concerned about whether the curricula in their programs were up to date and preparing them effectively for the job market.

As far as their own programs were concerned, most phone survey respondents reported some sort of effort to recruit women and minority students. These included 'outreach efforts', 'scholarships/funding', and 'special admissions'. Most faculty reported these efforts as being very or somewhat successful. Faculty reported a similar pattern when asked about efforts to recruit women and minority faculty. Here efforts included 'special recruitment efforts' and 'special considerations for applicants'. Opinion was split, however, regarding the success of such efforts. Most faculty reported that their efforts to recruit women were largely or somewhat successful, but efforts to recruit minorities was described by the largest number of respondents (28%) as being 'not very successful'. Admittedly, the next largest group (25%) report their efforts as having been 'somewhat successful', but the third largest group (21%)

was 'not at all successful'. Although the focus of this project was on gender and IT, these findings suggest that there continue to be issues for minorities in IT educational programs as well.

--The Face-to-Face Interviews (Rounds 1 and 2); Telephone Interview (Round 3)--

Overall, both female and male interviewees presented themselves as ambitious, confident, and successful students; most were highly or moderately confident about their employment prospects. This was the case in all three interview rounds.

The students' overall experience with their programs was positive in Years 1 and 2, less so in Year 3. Men were somewhat more positive in Years 1 and 2, while women were more positive in Year 3. These apparent changes over time should be interpreted with caution, however, since in round 3 both the gender of the interviewer and the modality of communication were different. Differences in self-reported satisfaction could have been affected by either factor. Another factor that might have contributed to students' lesser satisfaction in round 3 is that a number of students had graduated and were critical, in retrospect, of ways in which they felt that their programs had not prepared them for the job market. The students' main wish for change in their programs was to incorporate more practical experiences into the curriculum. Some women also wished for better support and better work-life balance, while some men wished for more funding.

Consistent with previous gender research, women gave more people-oriented responses when describing reasons for their satisfaction. The female interviewees described receiving somewhat more mentoring and being more satisfied with it; considered friends more important to their satisfaction; and credited their personal life for helping to create a good work-life balance. However, the men "fit in" better. More men said they had a good work-life balance; felt a sense of belonging in their programs; belonged to clubs and organizations, including in leadership roles; and felt that their personal values matched those of their field.

As regards equity issues, men more than women thought that both men and women were treated fairly in their programs. Women were more likely to think that women/minorities should be recruited, to be aware of specific recruitment/support activities by their programs, and to have participated in such activities. While most students agreed that men are advantaged in their IT field, and they took a somewhat negative view of that, most would not call themselves "feminists."

Consistent with previous research and with the results of the web survey, despite similarities in amount of computer use and use of computers for communication, men reported higher levels of computer skill; being more "techie," and knowing how to program more often than women. Further, men and women tended to define "techie" somewhat differently, with women placing greater emphasis on hardware and tinkering than men did.

An especially interesting finding that emerged from the interviews was that most students selected their program of study out of interest/enjoyment, and men and women described similar gratifications from their IT studies: creating something useful; making a difference; solving problems; overcoming challenges. However, women were much more willing to

consider CS/MIS than men were willing to consider LIS/IST as potential fields of study. For women, the main reason for not choosing CS or MIS was a perceived lack of technical background and skills, while some men commented that LIS and IST were not technical enough. This suggests that overcoming women's fears and misunderstandings about computer programming would increase the number of women in technical IT fields, and that overcoming men's (and society's) prejudices against applied, human-centered IT fields could reduce gendered hierarchies within IT.

We also conducted two focused analyses based on the round 1 interview data. One study analyzed IT students' gender consciousness in relation to their self-efficacy, which was operationalized in terms of self-confidence and ambition. Confidence was measured by noting mannerisms during the interview, such as eye contact or apparent nervousness, as well as hesitations, false starts, and backtracking. Ambition was coded on the basis of answers to questions about future plans, and in some cases on why they chose their major in the first place. Most of the interviewees were aware of the IT gender gap, although many were not concerned about it. Overall, female students' gender consciousness was higher than that of male students. Women who exhibited a high gender consciousness (who both were able to articulate gender differences that they saw in their programs or lives and indicated that they were bothered by those differences) also tended to have high self-efficacy relative to the female student population as a whole. To the extent that self-efficacy correlates with future success, this suggests that the IT students most likely to want to effect change are well positioned to be successful in their fields.

Another study focused on IT students' early computer influences and the impact certain individuals had on their educational and career choices. In many cases, students reported that parental encouragement and support contributed to their enthusiasm for computers. For female students, especially in applied IT fields, fathers were most often mentioned as important early influences. In contrast, male students, especially in computer science and information science, were more likely to refer to the influence of their mothers. This finding supports earlier research showing that the encouragement of parents, family members, and teachers helps students to have positive attitudes toward IT.

Additional findings for all three data sets are summarized in the attached findings file.

Training and Development:

This project contributed to the research skills and experience of the Project Director and co-PIs, who are in four different academic fields. It also provided training to a graduate student who served as the Research Associate for the project, three graduate students who served at different times as research assistants, and three other graduate students who contributed to the data analysis from the web survey/interview data/IT program websites. In addition, the two undergraduate students who assisted with the workshop received hands-on training in how to run a conference.

Outreach Activities:

Outreach activities for this project fall into three categories: Conference presentations, Presentations at Indiana University, and Research dissemination workshop.

Conference presentations (in chronological order)

Ahuja, M., Herring, S. C., Robinson, J. C., and Ogan, C. 2004. 'Exploring antecedents of gender equitable outcomes in IT higher education.' Paper presented at the ACM SIGMIS CPR (Association for Computing Machinery - Special Interest Group on Management Information Systems – Computer Personnel Research) Conference, Tucson, AZ, April 22-24.

Ogan, C., Herring, S. C., Robinson, J. C., and Ahuja, M. 2005. 'The more things change, the more they remain the same: Gender differences in attitudes and experiences related to computing among students in computer science and applied information technology programs at five U.S. research universities.' Paper presented at the 2005 International Communication Association Conference, New York, NY, May 28.

Robinson, J. C., and Ogan, C. 2006. 'Toward gender equitable outcomes in higher education: Beyond computer science.' Presentation at National Science Foundation ITWF & ITR/EWF Principal Investigator Conference, Raleigh, NC, April 2-4.

Goh, D., Ogan, C., Ahuja, M., Herring, S. C., and Robinson, J. C. 2006. 'Being the same isn't enough: Impact of male and female mentors on computer self-efficacy of college students in IT-related fields.' Poster presented at the American Education Researchers Association annual conference, San Francisco, CA, April 8.

Herring, S. C., and Marken, J. A. 2006. 'Implications of gender consciousness for students in IT programs.' Paper presented at the American Education Researchers Association annual conference, San Francisco, CA, April 10.

Presentations at Indiana University

S. Herring made a presentation on the project's goals and design to the IU Computer Science department Taskforce on Gender Equity on January 23, 2004.

C. Ogan made two presentations on mentoring, drawing on the project's findings. One was to the IU Informatics faculty in Spring 2006; the other was to the IU Women in Computing (WIC) organization in Spring 2007.

Research dissemination workshop

From September 28-30, 2007, we hosted a workshop to disseminate the results of, and best practices deriving from, the findings of this NSF project. The workshop took place in Bloomington, IN on the Indiana University campus. Approximately 50 individuals from the participating research universities, as well those from outside institutions who have an interest in gender equity in IT education, were in attendance. The group also included advanced placement computer science teachers.

The workshop began on Friday (9/28/07) with an opening reception. Saturday (9/29/07) was a full day of presentations and breakout sessions. The opening remarks and welcome were delivered by Sarita Soni, IU Vice Provost for Research, and Bobby Schnabel, Dean of the IU School of Informatics.

The presentations were divided into three clusters: Project Overview and General Findings, Individual Factors Contributing to Success, and Contextual Factors Contributing to Success. In addition to the presentations, responses from the high schools and programs designed to support women were incorporated into the sessions. Breakout sessions were designed to allow the participants to discuss issues related to mentoring, campus climate, and recruitment & retention at their institutions. The closing event on Saturday evening was a dinner with a welcome address from Caty Pilachowski, IU Dean for Women's Affairs.

The workshop concluded on Sunday (9/30/07) with a working brunch. The discussion was led by Lecia Barker and Joanne Cohoon of the National Center for Women & Information Technology (NCWIT). This portion of the workshop served to generate ideas for next steps and ways to move forward.

Based on the evaluations that were returned by the participants, the workshop was well-received. The following are some of the comments that were noted on the evaluation form:

'There are many smart and energetic people working on this challenge. That is very heartening!'

'The organization of the workshop was very useful. Yes, I made a few contacts that will be very beneficial to my goals for my program.'

'I thought the information was very interesting, I loved hearing from the different people, and got to meet and chat with various interesting people.'

Several participants also mentioned that they are interested in using our survey instruments and conducting a modified version of our study.

Based on feedback from the participants, we created a Google Groups forum as a way to continue the conversations that began at the workshop. One of the participants also invited us to add our workshop materials to the Computer Science Teachers Association (CSTA) Repository site (http://csta.acm.org/WebRepository/WebRepository.html). All of our materials from the workshop have been added to the site.

Journal Publications:

Herring, S. C.; Marken, J. A., "Implications of gender consciousness for students in information technology", *Women Studies Quarterly*, vol. , (2008), p. ., " " Accepted

Ogan, C. L.; Robinson, J. C., "'The only person who cares': Misperception of mentoring among faculty and students", *Women Studies Quarterly*, vol. , (2008), p. ., " " Accepted

Goh, D.; Ogan, C.; Ahuja, M.; Herring, S. C.; and Robinson, J. C., "Being the same isn't

enough: Impact of male and female mentors on computer self-efficacy of college students in IT-related fields", *Journal of Educational Computing Research*, vol. 37, (2007), p. 19., " " Published

Book(s) or other one-time publications(s):

Ogan, C., Robinson, J. C., Ahuja, M., and Herring, S. C. "Gender differences among students in computer science and applied information technology", bibl. pp. 279-300, (2006). *Chapter in a book* Published
of Collection: W. Aspray and J. McGrath Cohoon, "Women and Information Technology: Research on the Reasons for Under-representation"

Ahuja, M., Herring, S. C., Robinson, J., and Ogan, C. "Exploring antecedents of gender equitable outcomes in it higher education", bibl. Pg. 120-123, (2004). *Conference Proceedings* Published
of Collection: "ACM SIGMIS CPR (Association for Computing Machinery - Special Interest Group on Management Information Systems / Computer Personnel Research) Conference Proceedings"

Ahuja, M., Ogan, C., Herring, S. C., and Robinson, J. C., "Gender and career choice determinants in information systems professionals: A comparison with computer science", bibl. pp. 279-304, (2006). *Book Chapter* Published
of Collection: F. Niederman and T .A. Ferratt, "Human Resource Management of IT Professionals"

Herring, S. C., Ogan, C., Ahuja, M., and Robinson, J. C., "Gender and the culture of computing in applied IT education", bibl. http://www.igi-pub.com/reference/details.asp?ID=5067&v=tableOfContents, (2006). *Book Chapter* Published
of Collection: E. Trauth, "Encyclopedia of Gender and Information Technology"

Ogan, C., Herring, S. C., Robinson, J. C., and Ahuja, M., "The more things change, the more they stay the same: Gender differences in attitudes and experiences related to computing among students in computer science and applied information technology programs", bibl. 120, (2005). *Conference proceedings* Published
of Collection: "International Communication Association Conference Proceedings"

Herring, S. C., and Marken, J. A, "Implications of gender consciousness for students in IT programs", bibl. Paper presented at the American Education Researchers Association annual conference, San Francisco, CA., (2006). *Conference Proceedings* Published

Other Specific Products:

Data or databases

We have collected data from 1,768 web-based surveys of undergraduate and graduate students in IT-related fields at five major universities. In addition, data from three rounds of interviews (face-to-face and telephone) of undergraduate and graduate students in IT-related fields at the same five universities were collected. Our data collection instruments and

aggregated results are posted on our project website at http://www.itwf.informatics.indiana.edu/.

Our workshop materials have also been added to the Computer Science Teachers Association (CSTA) Repository site at http://csta.acm.org/WebRepository/WebRepository.html.

Internet Dissemination:

We have created a project website (http://www.itwf.informatics.indiana.edu/) that contains general study information, our data collection instruments and aggregated results, and information about project presentations and publications. This site will continue to be updated as new results and publications become available. Materials from our research dissemination workshop in September 2007 are also available from this website.

Our workshop materials have also been added to the Computer Science Teachers Association (CSTA) Repository site at http://csta.acm.org/WebRepository/WebRepository.html

Contributions:

Contributions within Discipline:

Previous research in IT education has found that girls and women are less likely to choose computing careers, based on aptitudes, interest, and experience regarding computers, and also because of cultural stereotypes and perceptions that computing is mostly a masculine activity. As yet, however, few studies have focused on the experiences of female students in IT programs outside the domain of computer science. Nor has any systematic comparison been attempted of such programs to determine which are most successful at recruiting and retaining female students, or what factors favor success. This study hypothesized that applied IT disciplines are more woman-friendly, in part because they incorporate practical applications of theories and because they may be more oriented toward human relationships. By analyzing the characteristics, attitudes, and experiences of women and men in four applied IT disciplines in comparison with students in computer science, this study aimed to identify encouraging and discouraging factors, and to produce comparative statistics, that can be used as a baseline in future research on IT education and gender.

We found that women in applied programs—especially LIS and IST programs, which had the highest female enrollments—tended to be more satisfied with their programs and more confident about their future careers than did women in CS and MIS. Conversely, men tended to feel most satisfied and confident in CS and MIS programs, which had the highest male enrollments. (Students of both genders in Informatics, which is a new IT discipline, tended to express less satisfaction and confidence than other students, in that they worried that their discipline was still somewhat undefined, and that employers might not recognize or appreciate their degree.) These findings support our hypothesis that applied fields (at least, those in which women are already well-represented) are more 'women friendly' than CS, and thus provide a viable access route for women into technology. At the same time, the findings

are problematic in the sense that both men and women report the greatest satisfaction and confidence in fields that continue traditional gendered paths. The fields in which women are most comfortable also involve less technical computer use (for example, they rarely require students to program computers) than do the fields in which men are most comfortable, thereby perpetuating a gendered technical/less-technical hierarchy within IT education. This hierarchy is reflected in the IT workforce: Applied IT workers such as instructional technologists and librarians are typically paid less than computer programmers and system administrators.

We also found, contrary to our hypothesis, that applied programs had fewer initiatives in place to promote IT to women, perhaps because they already had high female enrollments and considered that no further encouragement was needed. In contrast, CS units reported making the greatest efforts to recruit and retain women, over-represented women on their websites, and were most likely to have support groups for female students. Women in CS also expressed the greatest concern about gender inequities in IT. This sometimes contributed to their dissatisfaction with their programs, but some involved women were pushing their institutions from the inside to make changes, which is positive and necessary. These women seemed most likely to be future change agents.

Despite the efforts of CS programs and the presence of gender-aware female students, however, the CS programs had the lowest female enrollments. We attribute this to societal factors—the belief is still prevalent that CS and technical involvement with computers are for men, and there are too few alternative messages available on a societal scale to counter it. When asked, students had few other explanations to propose for the gender disparities in IT. It was rare that women reported experiencing blatant sexism or lack of access to resources in their programs, and they did not complain about the way computing was taught any more than men did. If anything, women reported receiving more mentoring than men did, and enjoyed the benefits of more special initiatives. At the same time, we observed evidence of backlash—the more attention paid to programs for women, the more some male students tended to protest that women were unfairly advantaged.

Some positive predictors also emerged from the study. The early encouragement of a parent of either gender correlated with choice of IT as a career, especially for women in CS. Encouragement is something that educators and counselors, as well as teachers, can provide. Early computer use, for communication as well as for game playing, was also found to be a predictor, and could be encouraged more in home and school settings. As the need for information technology professionals continues to grow, so too does the need to engage women and girls in courses of study that will qualify them for IT-related careers. Findings such as these of factors that encourage or discourage women to study IT can be used to inform programmatic recommendations aimed at moving more women into the IT pipeline through a diverse range of educational programs. (For more programmatic recommendations arising from this project, see the Take Home Findings sections of the findings document.)

Contributions to Other Disciplines:

The findings of this project have important implications for applied IT disciplines. To the extent that new IT paradigms such as are taught in schools of education, information, informatics, and business help to create new cultural associations, they have the potential to

contribute to reducing the overall persistent gender segregation in academic IT-related programs and, thus, IT employment. The findings of this project can help applied IT educators recognize and develop this potential, as well as to be aware of potential pitfalls, such as the recreation of gendered hierarchies around technology use within a single IT discipline. At the same time, although the situation for women in certain areas of engineering and medical science has improved, not all IT and related disciplines are experiencing similar outcomes. Our findings are important to other disciplines in that they suggest that the applied areas are not yet the success story we originally hypothesized, and that each discipline should be considered in its cultural context.

The project findings also contribute to scholarship on gender issues in each of the five disciplines we studied. One of the most striking findings is that the MIS student responses were similar to those of students in CS, and female enrollments in the MIS and CS programs were similarly low. However, the MIS programs appeared to be making fewer efforts to promote the recruitment and retention of women. Such programs could potentially benefit by studying and emulating some of the 'women-friendly' initiatives adopted by CS programs.

Moreover, in disciplines such as Women's Studies, as a result of discussion about sex differences in academia, mentoring and special programs are often implemented to create a more women-friendly environment for students. Our findings suggest that although women's programs are successful in that they reduce some of the challenges, they also raise awareness of the negative aspects in the community. This in turn can lead to an increase in expressions of dissatisfaction. Further, there is evidence that women shy away from involvement in women's programs because of the negative feedback they receive from their peers. With regards to mentoring, however, students do not perceive that faculty provide the mentoring services faculty say they are providing, and many students—especially women—expressed a wish for more mentoring. This could be a productive focus of women-centered programming.

Contributions to Education and Human Resources:

The focus of this project was IT education; in addition to the recommendations noted above, pedagogical and curricular recommendations arising out of our findings are discussed in the findings document. From the student perspective, the strongest recommendation was to provide more practical training in IT programs; both genders expressed this desire. Some women also wished for better support and better work-life balance, which for women more than men was related to their personal lives and quality of mentoring.

This project was also directly concerned with human resources, specifically, the development of skills and interest in girls and women in IT-related careers. Factors were identified that contribute to female students' decision to major in an IT discipline, as well as to their satisfaction once enrolled in an IT program.

Programs such as Women in Computing (WIC) and the Women in Science (WISP) Program at Indiana University have implemented activities and services based on findings from this research.

Contributions to Resources for Science and Technology:

We have created a project website (http://www.itwf.informatics.indiana.edu/) that contains general study information, the survey and interview instruments used to collect our data, project findings from the research dissemination workshop, and a list of project publications. We have encouraged participating academic units, survey/interview participants, and other interested parties to access the site to learn more about the project and its findings. The site will continue to be updated as new findings and publications become available.

We created a Google Groups forum for those who attended our research dissemination workshop as a way to continue the conversations that began at the workshop. At the invitation of one of the workshop participants, we also added our workshop materials to the Computer Science Teachers Association (CSTA) Repository site (http://csta.acm.org/WebRepository/WebRepository.html), so that members of that community can access and download the findings of our research.

Contributions Beyond Science and Engineering:

Many of the trends identified in this project, such as gender differences in self-efficacy, work-life balance, and mentoring experience, cut across disciplinary lines and are not exclusive to IT. As such, the project's findings have the potential to contribute to overall gender equity in higher education by identifying methods and practices that can be used across academic disciplines to attract and retain female students.

Special Requirements for Annual Project Report:

Categories for which nothing is reported:
Special Reporting Requirements
Animal, Human Subjects, Biohazards