



Getting to the Heart of it All

Connecting Gender Research, WIE Programs, Faculty & Corporate Partners

2012 Conference | June 25-27, 2012 | Columbus, Ohio



2012 WEPAN National Conference

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Using Outreach Programs to Increase Interest in Computing Majors

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Abstract

Increasing the female enrollment in computing programs is a common goal across the country. The College of Technology at Purdue University is employing a strategy to increase female and minority interest in baccalaureate programs through offering targeted outreach programs for recruitment. Many of the programs include other activities and may run over multiple days, but the focus of this paper is on the sessions that were designed to expose opportunities in computing to the student participants. Based upon student feedback from these computing sessions, the programs have been successful in raising student awareness of career opportunities in computing and in increasing interest in further study of computing. This presentation will share the descriptions of these sessions, the survey instruments used, the analysis procedure, and recommendations for future surveys to collect even more useful data.

Background

According to the U.S. Bureau of Labor Statistics, two of the fastest growing occupations are in the computing area (2010). Furthermore, two of the ten best paying jobs of the future identified by the Huffington Post are in computing (2011). Unfortunately, of the 64% of companies that reported having positions for which they were unable to find qualified applicants, computer engineers are among the top three unfilled positions (Manyika, Lund, Auguste, Mendonca, Welsh, & Ramaswamy, 2011).

Although the 2009-2010 Taulbee survey showed that computing baccalaureate degree production is on the rise (Zweben, 2010), the occupation growth predictions show that many more skilled computing graduates are needed. Given that in 2010, 58% of all bachelor's degrees were awarded to women (Manyika et.al., 2011) but only 13.8% of CS bachelor's degrees were granted to women (Zweben, 2010), sparking interest in computing in women remains an important source for addressing the computing workforce need.

Understanding why women are shying away from computing as well as understanding what women want from their future careers will help define how to generate that spark for computing disciplines. Stross (2008) identified a few reasons why there are fewer women interested in computing:

- The advent of the male subculture of action gaming drove women away, and efforts to create games that appealed to women failed to change the interest in pursuing study of computing.
- The “nerd” or “geek” stereotype was unappealing to women.

Harris, Cusman, Kruck, & Anderson (2009) confirmed the above explanations and offered additional explanations on why few women pursue computing majors, some of which follow:

- Women believe IT careers make balancing family and work life difficult.
- Women believe the male dominance in the field would make it impossible to advance.
- High school girls lack confidence in their computing abilities.

Harris, et.al. (2009) also offered strategies to increase interest in computing by women:

- Educate the key influencers of girls about computing.
- Provide mentoring support for women.
- Change the image of the profession.

Miller (2011) reported that the media attention from the movie, “The Social Network” and celebrity attention given to Apple’s founder, Steve Jobs, has drawn attention to the computing discipline, which may explain the continuing rise in interest on college campuses. The clearest explanations supported by an extensive study regarding career drivers are offered in the 2009 report by WGBH Educational Foundation and the Association for Computing Machinery. The report suggests that a strong career driver for women is societal relevance and impact, but those who ranked this high also ranked a career in computing low, suggesting that people may not realize that a career in computing can have positive, social impact.

Among the many strategies employed at Carnegie Mellon to yield the stark increase in female interest in computing is offering outreach programs to engage girls in science and technology (Blum, 2001). The greatest increase among baccalaureate computing programs regarding female interest has been realized at Harvey Mudd College. Their president explained that their strategy addressed the three factors that females do not pursue computing: “females think CS is not interesting, females think they will not do well in CS, and females think they will not feel comfortable in the CS culture.” (Klawe, 2011, p. 1-2). Although part of their solution involved curricular changes, their strategy of providing computing experience to increase interest and confidence may be applied to outreach programs (Klawe, Whitney, & Simard, 2009).

Blum & Frieze (2005) caution against developing programs to address perceived needs of specific groups, such as women, that may perpetuate stereotypes and promote marginalization. Their findings suggested that, “once a near critical mass of women students is established and supported, many assumed gender differences become less apparent, men and women appear to demonstrate many gender similarities, and above all they share a love of the field” (p. 20). Singh, Allen, Scheckler, & Darlington’s extensive review of the literature about the persistence of women in computing advised that “the conceptualization of women must be elaborated from a unitary notion of woman to include how gender intersects with race, class, sexual orientation, nationality, and other ways in which lives are socially constructed and constrained.” (2007, p. 517).

Technology Recruitment Programs Offered at Purdue University

The Computer and Information Technology Department at Purdue University has engaged in a number of recruitment programs and collected survey data to assess the effectiveness of these activities. The following list describes some of these programs:

- A variety of student groups visit the campus over one to five days to learn about various majors offered by the college. Each department has the opportunity to offer a one-hour session. A summary of the current programs offered through the college follows:
 - Two programs are offered in early spring where students participate in one-hour sessions offered by participating departments. The first program, Discovering Opportunities in Technology (DOiT), is tailored to 11th grade female high school students. The second program, Vision, is tailored to 11th grade underrepresented minority high school students.
 - One program is offered in mid fall where students participate in one-hour sessions offered by participating departments. This program, Windows of Opportunity for Women in Technology (WOWiT), is geared toward high school students involved in Project Lead The Way (PLTW) classes.
 - Several summer camps are available through the college that target different audiences. Technology Expanding All Minds (TEAM) is a 4-day camp that is designed for students who will enter 9th or 10th grade in the fall. Turned Onto Technology And Leadership (TOTAL) is a 4-day camp targeting current 7th and 8th graders. TAGS is a 3-day camp geared for 6th, 7th, and 8th grade girl scouts based on a collaboration between Purdue University's College of Technology and the Girls Scouts of America. Technology Experiences Cheerleading (TECh) was a 3-day camp for high school cheerleaders.
- Area middle schools bring groups of students to tour the campus and learn about a variety of programs including participation in 45-minute, interactive sessions during their one-day visits. These visits occur throughout the academic year.
- Surprising Possibilities Imagined and Realized through Information Technology (SPIRIT) is an NSF-funded program that is also offered through the department during the summer. The program includes a week-long summer camp for high school students. It is designed to spark interest in computing, especially in women. Although it is not designed to specifically recruit students into the department, because the program is delivered on the university campus and the majority of presenters are students and faculty in the department, it also serves as an indirect recruitment program for the department.

For SPIRIT, participants are exposed to a wide range of computing and technology applications via interactive, hands-on activities every day of the camp. SPIRIT activities are designed to highlight computing skills as a requisite skill for many disciplines. The activities are designed to show social relevance/impact. They are also selected to ensure that participants are able to successfully create a product by the end of session that they are often eager to show off to family, teachers, and friends.

For the remaining technology programs described above, the department offers just one, 45-minute to one-hour interactive session designed to introduce participants to computing in an engaging way, and other departments in the college similarly offer their own sessions to engage interest in their respective areas. The content of these sessions in terms of the actual activities completed by the participants varied. However, the organization and delivery of all sessions shared many attributes. Written materials were prepared that included step-by-step instructions to complete the activity while following along with the session instructor as well as to complete the activity at a later date. Additionally, the contact information of the presenters was included to

encourage future interaction initiated by the participant. The tools selected for the various activities were often ones that could be freely downloaded. This session attribute allowed participants to repeat the activity upon returning home.

The list below describes the activities used thus far:

1. Participants learn to use a tool to create animated stories. The instructor walks students through the process of creating a simple animated story. Then the students are placed into small groups and assigned a topic. Each group is tasked with using the tool to create an animation about their assigned topic and then present it to everyone at the end of the session. Two different tools have been used in different sessions: Scratch and Xtranormal
2. Participants learn about the job of a systems analyst. To practice this role, they brainstorm in groups the design of a new smartphone in terms of the features particular groups might need. They present their results to the rest of the class.
3. Participants learn about the types of jobs for IT professionals, including programming. Then they make edits to a generic Facebook quiz to customize it for their assigned topic, post it, and then try it out as well as try other quizzes created by other teams.

In some cases, the group size was too large to lead everyone through the activity together. Because one goal was to gauge the effectiveness of different activities, the large groups were divided into smaller groups and different activities were used for each sub-group; however, all participants completed the same feedback survey. Unfortunately, the survey did not include a question to identify the specific activity; however, the feedback from participants in these situations seemed to be consistent, regardless of the actual activity used.

Data Collected

An undergraduate student was hired to analyze the data collected from these sessions to help the outreach coordinators better understand the types of activities that best fit each group. Although the results showed that the sessions were effective in increasing awareness and interest, the lack of additional data about the participants limited the conclusions. The following section explains the data that were collected, the analysis of the data, the limitations of the study, and recommendations for an improved survey.

In order to assess the effectiveness of the single-opportunity exposure to computing, data was collected for seven of the recruitment sessions described in the previous section. These programs were DOiT, TAGS, TEAM, TECh, TOTAL, Vision, and WOWiT. (SPIRIT data was excluded because the participants completed multiple activities daily in the course of the week-long camp.) The method of data collection was an online survey conducted after each session. Table 1 identifies the ten questions that comprised the survey administered to all program participants.

Table 1
Survey questions for computing recruitment sessions

1. How familiar were you with IT prior to this session? (on a scale of 1 to 4)
1. Not at all familiar
2. Somewhat familiar
3. Moderately familiar
4. Quite familiar

Table 1
(continued)

<p>2. How familiar are you with IT now that you have completed this session? (on a scale of 1 to 4)</p> <ol style="list-style-type: none"> 1. Not at all familiar 2. Somewhat familiar 3. Moderately familiar 4. Quite familiar
<p>3. What role does IT play in day to day life (check all that apply)?</p> <ol style="list-style-type: none"> 1. It improves my life 2. It simplifies my life 3. It makes my life more complicated 4. It improves most people's lives 5. It has no impact on my life
<p>4. Do you plan to go to college?</p> <ol style="list-style-type: none"> 1. Yes 2. No 3. Maybe
<p>5. How interested are you in studying IT in college?</p> <ol style="list-style-type: none"> 1. I might consider pursuing IT study 2. I will definitely consider IT study 3. I am not sure whether I will study IT or not 4. Not at all. I plan to study _____
<p>6. How did today's session impact your intentions of pursuing an IT major in college?</p> <ol style="list-style-type: none"> 1. It made a big difference. I am now interested in looking more into IT. 2. It made some difference. I might consider IT. 3. It made no difference. I am still interested in IT. 4. It made no difference. I still have no interest in IT. 5. It made some difference. I might not want to pursue IT as much as I did before. 6. It made a big difference. I no longer have interest in IT.
<p>7. How does knowledge of IT impact your job opportunities?</p> <ol style="list-style-type: none"> 1. It increases the number of opportunities significantly 2. It increases the number of opportunities slightly 3. It reduces the number of opportunities slightly 4. It reduces the number of opportunities significantly 5. Not at all
<p>8. What job roles do you associate with IT (check all that apply)?</p> <ol style="list-style-type: none"> 1. Programmer/software engineer 2. Web designer 3. Systems analyst 4. Database administrator 5. Help desk support 6. Project manager 7. Business analyst 8. Network engineer 9. Security specialist 10. Mobile applications developer 11. Professor/teacher 12. Other _____
<p>9. What was the best thing you learned from this session?</p>
<p>10. How can this session be improved?</p>

There were a total of 192 survey responses collected, with the number of responses for each session shown in Table 2.

Table 2

Number of responses for each session (denotes sessions that targeted female students)*

DoiT*	TAGS*	TEAM	TECh*	TOTAL	Vision	WOWiT*
50	30	23	16	30	6	37

In analyzing the effectiveness of each session, the areas of focus were:

- Improvement in familiarity with IT, and
- Improvement in interest in IT.

Therefore, for the purposes of this paper, the main questions analyzed were 1, 2, and 6.

In evaluating the effectiveness of promoting familiarity with IT, a univariate analysis was first conducted on the change in familiarity after each session. The average familiarity score was calculated after each session, based on the initial score. Then the percentage change was examined. Next, a new variable called *Change* was created. *Change* was defined by subtracting the familiarity score before the session from the familiarity score after the session. The mean, standard deviation, and coefficient of variation (standard deviation divided by mean) for each session were examined. After the univariate analysis, a one-way ANOVA (analysis of variance) test was conducted to examine if there was any session that significantly outperformed the others. A one-way ANOVA test is used for comparative studies where different treatment (session in our case) may have different results (Kutner, Nachtsheim, Neter, & Li, 2004, p. 677). Kutner et al (2004, p. 681) identify the main assumptions of this model as follows:

- response variable is normally distributed,
- variance is constant, and
- observations are independent.

After examining some descriptive statistics, the data collected seemed to satisfy those assumptions.

In evaluating the effectiveness of promoting interest in IT, descriptive statistics were examined and a binary variable was created based on whether or not the session made a difference in promoting students' intentions of pursuing an IT major in college. Next, the mean value of this binary variable for each session was examined. Creating a binary variable simplified the analysis and allowed interpretation of the mean as the percentage of students increasing their interest after the session.

Results of Analyses

The univariate analysis results are shown in Table 3. As can be seen from the data, except for students with an initial familiarity score of 4, the sessions increased the students' familiarity in general. The sessions performed especially well on students who were initially unfamiliar with IT, increasing their familiarity by 136%.

Table 3

Average percentage change in familiarity score for all sessions combined

Initial Familiarity Score	After-session Average Familiarity Score	Count	% Change
1	2.36	101	136%
2	2.99	67	49%
3	3.42	19	14%
4	3.60	5	-10%

The mean, standard deviation, and coefficient of variation of the *Change* variable for each session are shown in Table 4.

Table 4

Univariate analysis of the change variable

Session	N	Mean	Std Dev	CV
DoiT*	50	1.02	0.74	0.73
TAGS*	30	1.33	0.66	0.50
TEAM	23	1.13	1.01	0.90
TECh*	16	1.13	0.62	0.55
TOTAL	30	0.90	0.99	1.11
Vision	6	1.50	1.05	0.70
WOWiT*	37	1.03	0.50	0.49

The desired traits for the variable are a higher mean and a lower standard deviation. A higher mean indicates that the session has more successfully increased students' familiarity in IT. A lower standard deviation ensures that the result is stable and therefore more reliable. In the investing world, the coefficient of variation is often used to determine how much volatility is assumed in comparison to the amount of return one can expect from an investment (DeFusco, McLeavey, Pinto, & Runkle, 2007, p.113). As a result, the coefficient of variation is used here in determining the quality of each session.

As can be seen from the data, sessions focusing on females (marked by asterisk) performed relatively well as evidenced by relatively low coefficient of variance (CV). A quantitative ANOVA analysis was performed below to further determine if any session statistically outperformed the others. The result from the ANOVA analysis is shown below:

```
proc glm data=analysis;
class session;
model change=session;
means session;
run;
```

The SAS System
The GLM Procedure

Dependent Variable: Change Change

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	4.3164564	0.7194094	1.20	0.3097
Error	185	111.1783353	0.6009640		
Corrected Total	191	115.4947917			

R-Square	Coeff Var	Root MSE	Change Mean
0.037374	71.21626	0.775219	1.088542

The initial hypothesis (H_0) of the ANOVA test is that all means are equal; there is no statistically significant difference among sessions. The alternative hypothesis (H_a) is that at least one session has a statistically different mean (Kutner et al, 2004, p. 698). The result shows p-value = 0.3097, which is higher than the 0.05 at the 95% confidence level. Therefore we conclude that although some sessions appear to have better performance, it still lacks statistical evidence. The remedies for that include implementation of a more standardized data collection process to collect more useful data, which will be discussed later.

The analysis for effectiveness in promoting interest is done by showing the distribution of the answers to question 6 and examining the mean of a binary variable, which indicates whether or not the session increased students' interest. See Figure 1 for a summary of the students' answers.

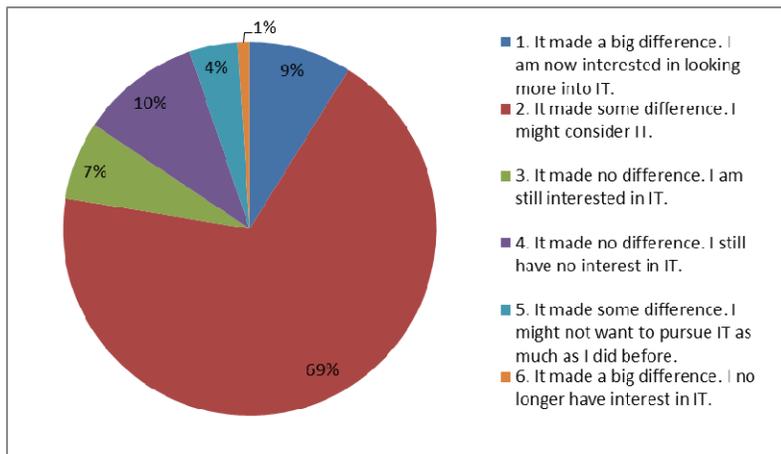


Figure 1. A summary of answers to survey question 6.

As the data shows, most students (78%) found the session to have increased their interest, while it also had some negative effect on some (5%) other students.

To simplify the result, a binary variable called *pursueIT* was created. Values were assigned with 0 representing a negative effect (no interest or reduced interest in pursuing IT, answers 4, 5, 6) and 1 representing a positive effect (increased interest or not reducing interest if initial interest existed, answers 1, 2, 3). Next, the mean of the variable for each session was calculated, as shown in Table 5. Because *pursueIT* is a binary variable, the mean can be interpreted as the percentage of students whose interest in IT increased or remained after the session.

Table 5

Average percentage of increase in interest in IT after attending session

Session	Total # of Students	Sum of PursueIT	Mean
DoiT*	50	46	92.00%
TAGS*	30	26	86.67%
TEAM	23	17	73.91%
TECh*	16	14	87.50%
TOTAL	30	17	56.67%
Vision	6	5	83.33%
WOWiT*	37	37	100.00%

As shown in Table 5, the four sessions that targeted female students achieved the highest percentage among all groups. One of these sessions, WOWiT, had a mean of 100%, i.e. after the session all students were more interested or still interested in IT. Combining these results with the results for promoting awareness, the outreach programs on average performed better on all sessions targeting women compared to the other sessions.

Limitations of Study

Despite the positive impact shown, there are some limitations of this analysis as well as the data used to conduct analysis. First of all, the data collected are mostly outcome variables, i.e. they are indicators of the effectiveness of the sessions, but none of them are explanatory variables. Therefore, although some sessions significantly outperformed the others, it is not clear exactly what caused these differences. Secondly, improvements on standardizing the data collection process for future sessions are planned. This change is needed because there are other sessions being taught but the data from those sessions are not being collected or are collected differently, such as the data collected for SPIRIT. By increasing the size of the data collected, the results should become more credible. To mitigate these limitations, the recommended steps include:

1. identify outcome variables and explanatory variables,
2. revise the questionnaire accordingly, and
3. standardize the data collection and analysis process for all sessions.

Recommendations for an Improved Survey

In order to include outcome variables and explanatory variables, the following additional data should be collected:

1. A description of the session being surveyed
2. The instructor who taught the session
3. Gender and ethnicity of the attendees
4. Group size
5. Activities conducted
6. Software/tools used
7. Session length
8. Participant interaction level

These are the potential factors that likely impact the effectiveness of a session; therefore, it is important to include them in future data collection. Tracking this additional data will make it possible to assess whether or not the session design and teaching methods had an effect on the survey results. This knowledge will allow the right adjustments to be made by running a regression analysis on the relationship between those explanatory variable and those outcome variables. If a variable, for example session length, is found out to be statistically significant and has a positive effect, then the length of the session should be increased to allow students more time on their activities. If sessions taught by a specific instructor are found out to be significantly more effective than other sessions, then session coordinators may want to study the teaching methods employed by this instructor and implement them on other sessions.

The following standardized analysis procedure is suggested:

1. Obtain survey data from Qualtrics and convert it into Excel
2. Input the following variables for each data point:

- Gender (binary)
 - Ethnicity
 - Age
 - Interest_before (1-10)
 - Interest_after (1-10)
 - Interest_change
 - Familiarity_before (1-10)
 - Familiarity_after (1-10)
 - Familiarity_change
 - Length (total minutes)
 - Amount of interaction (as percentage of total length of session)
3. Input other variables obtained from session description
 4. Run regression of effectiveness on each of the explanatory variables and analyze the results
 5. Construct and maintain a database for past sessions

Using the above recommended procedure will help identify the differences among different student groups, i.e. female students or minority students, to determine the most impactful class design for each group. This knowledge should help programs better reach target groups.

Conclusion

This paper presented one approach for increasing female and minority interest in IT through offering targeted outreach programs. The results of the analysis and student feedback demonstrate that these programs have been successful in raising student awareness and interest. However, the results are limited due to missing questions on the standard surveys. In order to better evaluate the effectiveness of these sessions, it is important to include additional questions that will allow more targeted analysis of the effectiveness of each type of outreach session. Because the outreach sessions described in this paper are conducted annually, the authors intend to revise the standard survey to get more concrete results that will identify the types of activities that are most effective for each audience type.

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