Gender, Perceptions, and Reality: Technological Literacy Among First-Year Students

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ABSTRACT

Recent studies have found that gender gaps in information and communication technology (ICT) skills exist, despite changing gender role expectations for men and women. In this paper we report on survey results from an ongoing longitudinal study of ICT skills which found that—in general—first-year students were confident in their ICT skills. However, comparison of student skills in four major technology domain areas indicates that there are differences between the male and female first-year students in levels of confidence. We also report on a second, follow-up study designed to examine the actual ICT skills of the first-year students. This investigation indicates that both male and female students have greater confidence than actual skill. The study also found that both male and female students have approximately the same level of actual ICT skills. These findings suggest that female students, although possessing ICT skills similar to their male counterparts, do not perceive themselves as competent users of technology. These differences in ICT skill confidence have implications for fluency with technology in academia as well as the recruitment and retention of women in the Computer and Information Sciences.

Categories and Subject Descriptors

K.3.2 [Computer and Education]: Computer and Information Science Education – Literacy.

General Terms

Human Factors.

Keywords

Gender, Technology Skills.

1. INTRODUCTION

Common to all modern academic disciplines is a need for information and communication technology (ICT) skills, which—in the academia of the 21st century—as a necessary prerequisite for information literacy and lifelong learning [1]. Information technology skills enable an individual to use computers, software applications, databases, and other technologies to achieve a wide variety of academic, work-related, and personal goals. Ideally, “fluency with technology” focuses on understanding technology and becoming more skilled through continued use [1]. First-year students who are fluent with technology should be able to use computer technology to capture, process, store, and transfer information which in turn enables them to focus on information content, communication, analysis, information searching, and evaluation [1, 7].

Despite the documented need for ICT skills, gaps in basic skills exist among first-year college students [9]—a group that is often assumed to possess a high degree of technological sophistication. Unfortunately, women may still be on the far side of this fluency gap. At a time when the number of women in Computer Science (CS) programs is plummeting [15], this further compounds the difficulty in attracting females to the major.

2. GENDER AND ICT SKILLS

A review of the literature regarding the impact of gender on both ICT skills and attitudes towards ICT shows a strong difference in the way females and males approach technology. Gender studies have found that women are generally less frequent and less confident technology users when compared to their male counterparts. For example, Liff and Shepard’s study on Internet use and gender concluded women spend less time using the Internet and do not use the Internet in the same way as men. Women use the Internet “as an additional communication medium” while men tend to use the Internet as a source of “fun, enjoyment and pleasure” [12]. Hanson [10] reported that men and women employ computer technology for different tasks. Women prefer interaction with computers that provide help or make a connection with someone, while men see computers as extensions of power. Hanson concluded that “it’s not that they (women) don’t have skills but rather that they don’t want to be part of the computer culture” and will choose other interests over ICT.

Busch [3] found that female students report less self-efficacy with regard to complex computing tasks, have less programming experience, and have less experience in playing computer games than their male counterparts.

Most studies recognize that differences between men and women in use of and attitudes toward ICT stems from gender role socialization. Gender identity is formed through a process by which societal norms and attitudes are internalized. The process
begins within the context of family life but parents, schools, and peers reinforce existing gender role expectations (See Figure 1). For example, Busch [3] reports that “parents still regard computers as a male rather than a female, or common domain. Significantly more male students than female students reported having had access to a home computer before they enrolled in college” (p. 7). However, this trend in access may be changing as studies show more females reporting access to high-speed broadband connections [14].

The role of the family and the peer population has a significant impact on both actual and perceived ICT skill levels. Shashaani [13] finds that “parents, especially fathers, encourage their sons more than their daughters to learn about computers. Parents most often purchase computers and computer games for their sons, and not for their daughters… lack of female-user roles models at home may influence girls’ self-confidence that learning and working with computers are difficult tasks, and that computers are in the masculine domain” (p. 362). In the often male-dominated CS curriculum, the low level of female peers and/or role models can be a social challenge for many female students, leading to diminished levels of confidence in their ICT abilities [11].

Access and use of computers in the K-12 school curriculum is another critical factor in first-year students’ level of computer literacy. Gendered experiences in classroom technology exposure have been well-documented. Colley [5] notes that “males outnumber females in programming courses, and males spend more time programming than females, while similar numbers of males and females, or even a majority of females is found when enrollments for other computer applications, especially word processing, is considered” (p. 20). Colley attributes the large number of females in applications (e.g. word-processing) as an extension of typing—a historically female vocation. In her study of the K-8 classroom environment, Gilmour [8] confirms these differences by documenting the aspects of education software that are highly gendered. For example, Gilmour identifies math software that employs traditional “shoot-'em-up video games” or the use of mostly male character figures as representative of these gender differences.

Cognitive developmental theory explains that young children express strong preferences for sex-typed activities and toys, including computer entertainment software [4]. Peer networks act as powerful enforcers of this gender schema. Gilmour [8] documents that computer competency in K-8 may be perceived as a male-stereotyped area of achievement. She documents peer perception of any girl “extraordinarily competent with computers” as a “tomboy”. Irani [11] reports a similar phenomenon, where the culture of the “hardcore” CS student (rooted in traditional gender expectations for men) leaves female students feeling inadequate for the major. Busch [6] found that men receive significantly more encouragement from friends (and parents) than do women. Busch found that “male students are part of a social network that is more concerned about computers, and where the use of computers gives them a higher social status” (p. 7).

Skeptics may argue that gender role stereotypes have diminished in our society since these earlier studies. Nonetheless, Bem [2] has argued that the enculturation lens related to gender is thoroughly embedded in all aspects of society. The consequence is that—generation after generation—gender polarization is reproduced. This study seeks to determine whether gender differences in access and ICT skills continue to exist among a recent cohort of first-year students.

3. INITIAL STUDY
3.1 Design and Participants
All first-year students attending a testing and advising program at two branch campuses of a large university were asked to participate in a survey on their ICT skills and ICT access. Total program participation included 502 first year students. The survey response rate was 57.6% (n=289). Although the response rate is considered robust, a large number of program participants were under 18 at the time of their campus visit (summer 2004) and were disallowed from the pool of responders. There is the possibility that the students who did not respond were those with minimal computer skills and who found the task of completing the survey daunting. However, a student technical aide was always present to assist students with computer related questions.
The respondent demographics indicate a diversified population. The respondent population was 43.9% female and 56.1% male. The respondents came from a variety of communities – 29.8% from a rural community, 34.9% from a suburban community and 34.6% from an urban community. The respondents were mostly White (72.3%) with 12.8% Black, 6.6% Asian, 6.2% Latino and 2.1% other. They were predominately 18 (77.9%) and 19 (12.1%); only 10% were between 20 and 54. Mother’s educational level was High School Graduate (33.6%), Postsecondary school other than college (13.1%), Some College (14.5%), College Graduate (20.8%), and Graduate Degree (5.4%). Father’s educational level was High School Graduate (34.9%), Postsecondary school other than college (7.3%), Some College (12.5%), College Graduate (15.9%) and Graduate Degree (11.1%). The majority of respondents (44.6%) reported a family income under $40,000. A majority had home computer access (90.7%) and home Internet access (82.4%). School computer and Internet access were substantially lower - 37.7% for both.

3.2 Instrumentation
The existing literature on technology literacy provided the pool of ICT skills considered important to the success of first-year students [1]. We used that literature to identify 20 technology skills on which the students rated themselves from 1-no knowledge, 2–beginner, 3–good, 4–intermediate, and 5–expert knowledge. These skills were from four domains as Basic Computing, Applications, Internet and Research. In the Basic Computing domain the students rated themselves on skills such as installing and removing programs and copying, deleting and moving files. In the Applications domain students rated themselves on the use of programs such as word processors, spreadsheets and presentation software. In the Internet domain the skills they rated themselves on included using a URL, performing basic Web searches, and using email and instant messaging tools. The last domain was the Research domain, where the students rated themselves on using library databases, using citations properly and performing advanced searches.

3.3 Results
Means, standard deviations and One-Way ANOVA F-ratios of skill levels are shown for females and males in each of the four ICT skill domains in Table 1. There were no significant differences between male and females students in three domains—Applications, Internet and Research. However, significant male/female differences exist for the Basic Computing domain. Male students rated themselves as more skilled in this domain ($\bar{X}=4.3$) than female students ($\bar{X}=3.9$).

Table 1. Skill Differences between First-Year Students

<table>
<thead>
<tr>
<th>Skill Domain</th>
<th>Female</th>
<th>Male</th>
<th>F-ratio</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Computing</td>
<td>3.9 (1.08)</td>
<td>4.3 (0.96)</td>
<td>11.146</td>
<td>0.001</td>
</tr>
<tr>
<td>Applications</td>
<td>4.3 (0.74)</td>
<td>4.4 (0.67)</td>
<td>1.194</td>
<td>0.276</td>
</tr>
<tr>
<td>Internet</td>
<td>3.9 (0.95)</td>
<td>4.1 (0.92)</td>
<td>2.644</td>
<td>0.105</td>
</tr>
<tr>
<td>Research</td>
<td>3.2 (1.03)</td>
<td>3.2 (1.06)</td>
<td>0.144</td>
<td>0.705</td>
</tr>
</tbody>
</table>

One-Way ANOVA was conducted to determine which of the specific Basic Computing domain skills showed gender differences. The results are shown in Table 2. Specifically, the key significant differences are in the areas of installing and removing programs and in copying, moving and deleting files. Male students rated themselves as more skilled at installing programs than female students ($\bar{X}=4.4$ vs. $\bar{X}=3.8$), more skilled at removing programs than female students ($\bar{X}=4.3$ vs. $\bar{X}=3.8$), and more skilled at moving and deleting files ($\bar{X}=4.3$ vs. $\bar{X}=3.7$).

Table 2. Basic Computing Skill Differences

<table>
<thead>
<tr>
<th>Skills</th>
<th>Female</th>
<th>Male</th>
<th>F-ratio</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install programs</td>
<td>3.8 (1.3)</td>
<td>4.4 (1.0)</td>
<td>9.82</td>
<td>0.002</td>
</tr>
<tr>
<td>Remove programs</td>
<td>3.8 (1.3)</td>
<td>4.3 (1.2)</td>
<td>13.468</td>
<td>0.000</td>
</tr>
<tr>
<td>Change Monitor properties</td>
<td>4.4 (1.0)</td>
<td>4.5 (1.0)</td>
<td>0.482</td>
<td>0.488</td>
</tr>
<tr>
<td>Move, Copy, and Delete files</td>
<td>3.7 (1.3)</td>
<td>4.3 (1.1)</td>
<td>17.311</td>
<td>0.000</td>
</tr>
<tr>
<td>Scan document for a virus</td>
<td>3.1 (1.5)</td>
<td>3.4 (1.4)</td>
<td>1.841</td>
<td>0.176</td>
</tr>
</tbody>
</table>

Although the Internet domain was not significant it had a low enough significance value ($p \leq 0.105$) that further investigation was warranted, so a One-Way ANOVA was performed to determine if any skills showed gender differences. The results are shown in Table 3. Specific gender differences exist with regards to downloading files and adding bookmarks. Male students rated themselves as more skilled at downloading a file from the Internet than female students ($\bar{X}=4.4$ vs. $\bar{X}=4.1$) as well as more skilled at adding bookmarks to a browser than female students ($\bar{X}=4.0$ vs. $\bar{X}=3.6$).

Table 3. Internet Skill Differences

<table>
<thead>
<tr>
<th>Internet Domain</th>
<th>Female</th>
<th>Male</th>
<th>F-ratio</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate an Internet site using a URL</td>
<td>3.9 (1.3)</td>
<td>4.1 (1.2)</td>
<td>1.247</td>
<td>0.265</td>
</tr>
<tr>
<td>Download a file from the Internet</td>
<td>4.1 (1.1)</td>
<td>4.4 (1.0)</td>
<td>4.924</td>
<td>0.027</td>
</tr>
<tr>
<td>Perform a basic Internet search with a search engine</td>
<td>4.6 (0.8)</td>
<td>4.6 (0.9)</td>
<td>0.012</td>
<td>0.913</td>
</tr>
<tr>
<td>Add bookmarks to a browser</td>
<td>3.6 (1.5)</td>
<td>4.0 (1.3)</td>
<td>5.81</td>
<td>0.017</td>
</tr>
<tr>
<td>Access and chat using Instant Messaging (IM)</td>
<td>4.3 (1.2)</td>
<td>4.4 (1.0)</td>
<td>1.519</td>
<td>0.219</td>
</tr>
<tr>
<td>Attach a file to an outgoing e-mail</td>
<td>3.8 (1.3)</td>
<td>3.9 (1.3)</td>
<td>1.525</td>
<td>0.218</td>
</tr>
<tr>
<td>Open a file attached to an incoming e-mail</td>
<td>4.0 (1.1)</td>
<td>4.1 (1.1)</td>
<td>0.486</td>
<td>0.486</td>
</tr>
</tbody>
</table>
Chi-Square analysis was used to determine if there were gender differences in access to computers. Female students reported significantly less access to a computer than males (χ² = 7.302, p = 0.007). Only 89.0% of the female students had access to a computer while 96.9% of the male students had access to a computer.

4. FOLLOW-UP STUDY

4.1 Design and Participants

In order assess the "actual" ICT technology skills of first-year students, a pilot study was conducted in fall 2004. A written assignment was created that enabled the researchers to rate the actual performance of first-year students in three technology skill domains--Applications, Internet and Research. The Basic Computing domain was excluded due to concerns over security.

4.2 Instrumentation

Students were asked to write a research paper that required the completion of ten technology-related tasks. These ten tasks matched ten of the skill areas identified in the ICT survey of first-year students. These tasks included providing references; formatting the paper using a proper style such as APA, MLA or Chicago; saving the document as a rich text file; and emailing the paper to the lead researcher. The students were given two weeks to complete the assignment. The students were given no extra instruction on how to write the paper or perform any of the tasks. The assignment was scored based on the completion of the ten selected skills. Each paper was scored on a 10-point scale based on whether or not they properly completed each task.

Thirty-eight students completed the assignment. The students who volunteered were recruited from 10 sections of a First-Year Seminar course offered at the campus. Not all First-Year Seminar instructors participated in this study. Each section had approximately 20 students, thus the response rate was 19%. All of the students who participated in the follow-up study had taken the earlier survey. There were 14 women and 24 male students. The sample should not be considered a representative sample of student volunteers, further research correlating ICT skills with perceived skills is needed. However, these preliminary results are strongly suggestive that both men and women have a greater degree of confidence in their ICT skills than their performance indicates.

4.3 Results

One-Way ANOVA F-ratios were computed between the ten chosen skills from the research assignment from the First-Year Seminar course and the original ICT survey. There was a significant difference in the mean scores between first-year students completing the assignment (X̄ = 6.43, SD = 2.10) and students rating of perceived skill as determined from the ICT survey (X̄ = 8.22, SD = 2.22) (F = 8.243, p ≤ 0.005). In other words, students are actually less skilled than they perceive. There was no significant difference between male and female participants (F = 0.689, p = 0.407). Given the small non-representative sample of volunteers, further research correlating ICT skills with perceived skills is needed. However, these preliminary results are strongly suggestive that both men and women have a greater degree of confidence in their ICT skills than their performance indicates.

Busch [3] found that female students had less self-efficacy with regard to complex computing tasks than their male counterparts (p = 0.7). A decade later, this study confirms the ongoing confidence gap between female and male first-year students in key ICT skill areas—specifically the Basic Computing domain. These differences in ICT skill confidence have implications for both academic performance and recruitment/retention of women in CS and IS. Because women are significantly underrepresented in these ICT disciplines, recruitment efforts must address both fluency of skills and female self-efficacy.

5. DISCUSSION

Investigation of first-year student’s actual ICT skills indicates that both male and female students have greater confidence than actual skill and that both male and female students have approximately the same level of actual ICT skills. Based on the findings from the ICT survey, the majority of first-year students have access to computers at home or at school, although female first-year students report less access. In general, the majority of first-year students were confident in their ICT skills—although it is worth noting that some reported few ICT skills. Comparison of the four major technology domain areas indicates that female first-year students were less confident of their skills in the Basic Computing domain than male students—specifically in the area of installing and removing programs and in copying, moving and deleting files. In addition, female students have less confidence than male students in downloading files and adding bookmarks.

Cross and Steadman [6] argued that "Self-efficacy models of motivation suggest that students' beliefs about their ability to succeed at a learning task are more important that their actual skill levels or the difficulty of the task" (p. 80). The implications of self-efficacy theory are clear when considering the comparatively few women in the ICT field. First, women have been socialized to believe that they lack the ability to succeed in math and ICT fields such as CS and IS. This keeps them from enrolling in challenging math and CS classes and --if they do enroll--to drop-out when they lack the confidence to perform successfully. Second, women may feel confidence in some ICT domains but not others, thus limiting their choices of majors and occupations. What this suggests for the ICT field is the importance of confronting female students with an 'incremental' view of intelligence that motivates them to take on challenges to increase their skills and knowledge in what they believe to be a male-dominated domain and providing them with tasks they can perform successfully. Classroom research is needed that will inform CS and IS teachers on how to accomplish these two goals.

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7. REFERENCES


