# Implicit Association Test as an Indicator of Gender Bias in Computer Fields

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**Abstract** –Although gender bias in technical fields was observed by the author in the early days of her career, thirty years ago, it was her expectation that attitudes of current students would be much more gender neutral. To test this hypothesis, she assigned students in a Computer Ethics class to write about the Gender Gap in computer fields, then take the Harvard Implicit Association Test (IAT) relating gender and science, and finally to reflect on the results of the IAT. It was the expectation of the author that students today would perceive themselves to be completely unbiased, but would, in fact, be slightly more biased than they believed. Results, however, were both surprising and concerning. This paper discusses the assignment, the results, and reflections on the current state of perceptions of women in the computer field.

*Keywords:* Gender bias, Computer education

## BACKGROUND

At the University of Tennessee at Chattanooga, all Computer Science and Computer Engineering students are required to take CPSC 3610, "Ethical and Social Issues in Computing." According to the *2013-14 Undergraduate Catalog*, the purpose of this course is to examine " the ethical and social issues arising from advances in computer technology and the responsibility that computer professionals and users have with regard to computer use by focusing on the intrinsic link between ethics and the law, how both try to define the validity of human actions, and on the moral and ethical dilemmas created by computer technology that challenge the traditional ethical and moral concepts."[1] The course uses readings and discussions of classic and current ethical theories, as well as current news coverage related to computer issues, to inform, explore, and shape student attitudes toward state-of-the-art ethical issues which arise in computer professions.

One of the student outcomes which is required to be assessed in this course is awareness of complex social issues such as the Gender Gap in computer professions. In this context, Gender Gap may be defined as the disproportionate under-representation of females in computer professions compared to their representation in the general population and in the population of college students. According to the report "Why So Few? Women in Science, Technology, Engineering, and Mathematics" published by the American Association of University Women,

> In elementary, middle, and high school, girls and boys take math and science courses in roughly equal numbers, and about as many girls as boys leave high school prepared to pursue science and engineering majors in college. Yet fewer women than men pursue these majors. Among first-year college students, women are much less likely than men to say that they intend to major in science, technology, engineering, or math.... By graduation, men outnumber women in nearly every science and engineering field, and in some, such as physics, engineering, and computer science, the difference is dramatic, with women earning only 20 percent of bachelor's degrees. Women's representation in science and engineering declines further at the graduate level and yet again in the transition to the workplace. [2]

In order to gauge the level of current student perceptions of the Gender Gap and the place of women in the future of the profession an assignment was devised to include a description of the student's conscious attitudes, and also participation in an Implicit Association Test [3] to provide a measure of subconscious biases.

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## THE ASSIGNMENT

The assignment given to the students each semester was as follows:

- Write a paragraph on why you think that there are so few women in engineering, the sciences, computer sciences, etc., paying special attention to whether you think there is any bias involved.
- AFTER writing the paragraph, go to the web site at https://implicit.harvard.edu/implicit/demo/takeatest.html
- Click on "I wish to proceed" and select the Gender-Science IAT (there are other, similarly-named ones, so be sure to do the correct one).
- Do a screen print (if possible) of your results (if not, tell what they are), and then write your reaction to your score—was it what you expected? If not, in what way was it not? [4]

### The Implicit Association Test

An Implicit Association Test (IAT) is a simple computerized test in which participants are asked to sort lists of words into two groups using only two letters on the computer keyboard, typically "e" for one category and "i" for the other. [3] For the Gender-Science IAT, participants are first asked to sort a list of gender-related words (such as aunt, grandfather, and son) into categories of "Male" and "Female." Next, they are asked to sort a list of words describing fields of study (such as biology, poetry, and history) into categories of "Science" and "Liberal Arts." Then, participants sort a mixed list (aunt, arts, husband, physics...) into combined categories, "Male OR Science" and "Female OR Liberal Arts." Finally, a mixed list is again sorted, but categories are combined differently, e.g., "Male OR Liberal Arts" and "Female AND Science." [5] Participants in IATs are encouraged to perform the tests as quickly as possible without making errors. A score is calculated based on the difference in reaction time of the participant in sorting the mixed lists into the combined categories—i.e., in the case of the Gender-Science test, does it take the participant longer to correctly identify the sciences when they are in the category with female words than it does to identify them when they are associated with male words? The relative amount of time difference is used to assign a degree of automatic association. A significant number of studies since the first publication of the IAT methodology in 1998 have indicated the efficacy of Implicit Association Tests in capturing underlying attitudes, resistance to faking (e.g., participants deliberately manipulating scores), and repeatability of results. Additionally, a review of IAT studies indicates that for topics of social sensitivity (e.g., racial or gender issues), the validity of IAT measures was "relatively high" compared to the attitudes self-reported by participants. [3]

### Goal of the Assignment

The goal of the assignment described above was to have students compare their understanding and viewpoints on the Gender Gap before taking the Implicit Association Test with their measured implicit bias, then write a reaction to those results: were the results what the student expected? If not, in what way were they different?

The author's expectation was that current students in computer fields would *believe* themselves to be completely unbiased in regard to gender and scientific fields, but would discover that they had a slightly greater bias than expected. The remainder of the assignment would then allow students to reflect on their previously unrecognized biases, and give opportunity for growth of awareness of gender bias in the current profession. However, the results were not as expected.

## THE RESULTS

The results given in Figure 1 are the results of the Gender-Science IAT reported by Harvard Project Implicit, based on 299,298 web responses between July 2000 and May 2006. [6] The author had expected that the results from the CPSC 3610 Ethics class, composed primarily of students majoring in Computer Science or Computer Engineering, would show a smaller percentage of students strongly associating men with science, particularly given the 40% female faculty in the UTC Department of Computer Science and Engineering. However the results from the Spring 2011 section of the class, consisting of 25 male and 3 female students, showed an even higher "strong" automatic of men with science than the general population results from Harvard. Results are shown in Figure 2. Although data is only saved in semesters when ABET assessment of the course is being performed, results in subsequent semesters have been consistent, and have continued to show similar strong correlations of men with science.

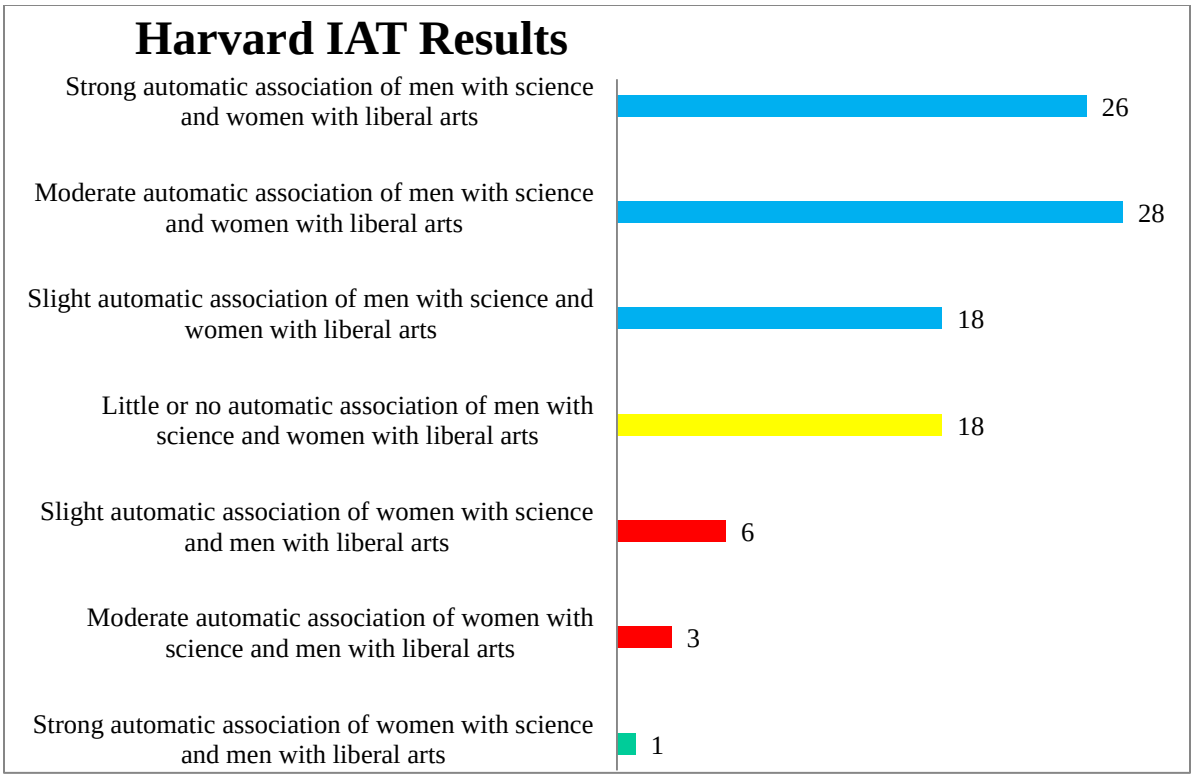


**Figure 1 Harvard IAT Results for Gender-Science [6]**

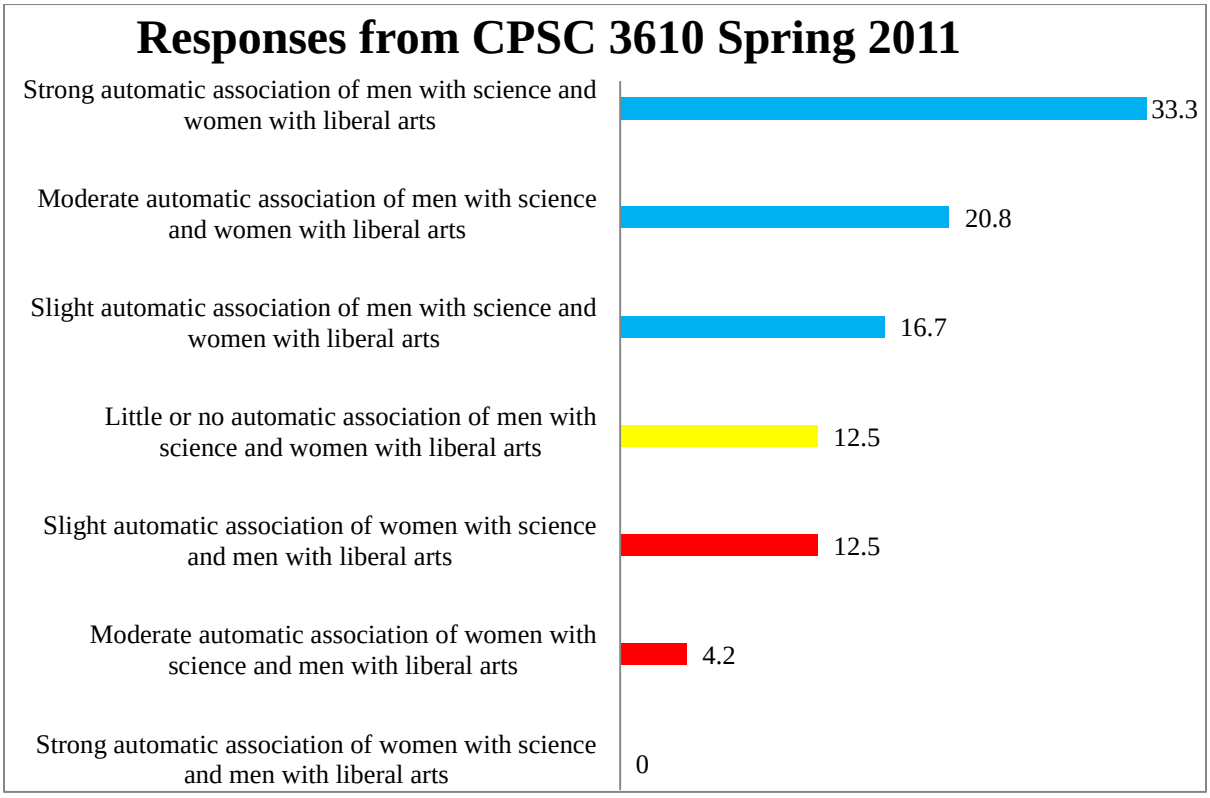


**Figure 2 IAT Gender-Science Results from UTC**

While the strong links between men and science were surprising and somewhat concerning, more troubling were the comments from the students in their reflections on results of the IAT. Rather than being surprised or concerned by the possible bias demonstrated by the IAT, over half the students in the class seemed to regard this association of men with science as normal and expected. Student comments, cited anonymously to protect student privacy included, "Girls just aren't interested in stuff like computers," "Women's brains can't handle the advanced math—it's a right brain, left brain thing," and "Women are better at nurturing than at technical things." Reasons given for this association were similarly disturbing: "Engineering has been, and always be, a male-dominated field," and "It's nothing to do with societal bias—it's how girls are raised." Student views on prospects of women's success in the professional world seemed murky as well. One student wrote that, "[One] reason that a woman would have a hard time getting [into] and progressing through an engineering or computer science career is that sometimes men have too much pride. There are men who would not tolerate knowing that a woman could do a better job." Another gave as his reason for few women in engineering as related fields as, "...women usually draws [sic] maximum benefits from their employers. If employers do not want to give a lot of benefits to an employee, they would most likely hire a male. I do not really believe there is any bias involved with this because the company just does not want to spend extra money on benefits."

While the heavy association of men with science surprised the author, it is not without precedent. The unpublished paper by Smyth, Greenwald, and Nosek [7] indicates, based on two IAT studies including over 110,000 college graduates and students, that the male students who have the strongest automatic association between men and science are the most likely to major in these fields, while women with similarly strong associations were least likely to do so. This would be consistent with the results in the UTC course, as most of the respondents were men in technical fields. The study [7] also indicated that women who majored in scientific fields tended to have the least automatic association of men with science. Researchers found that "For women in both studies, implicit stereotyping was more strongly related to majoring in STEM [Science, Technology, Engineering, and Mathematics] than was SAT-math performance, an indicator of math ability that is often prominent in models of post-secondary STEM interest and achievement." This could present questions that are difficult to answer: if the male students in the STEM fields are more likely than the general population to hold stereotypes about the appropriateness of male and female roles in those fields, how does this affect the female students in these majors? And if stereotypical ideas of appropriateness of females in science are an indicator for which women will go into those fields, how can the number of women in STEM areas be significantly increased, both at the university level and in the profession?

This is especially concerning, as some studies indicate that women's beliefs of male/female abilities affect women's performance appreciably. In a study by Spencer, Steele, and Quinn, cited in [2], male and female first year psychology students at the University of Michigan were given a test based on the math portion of the Graduate Record Exam. Although all of the students had similar math abilities and backgrounds, the results varied significantly based on what students were told before the test was taken, as seen in Figure 3. If the students were told that "there were no gender differences in test performance," male and female performance was very similar, and differences were not statistically significant. However, if the students were told that "men tend to do better," male performance increased slightly, and female performance decreased very significantly. Although this is only one study, it does suggest that student expectations of male and female performance can affect the level of accomplishment of female students in particular.

## WHAT NEXT?

It is obvious that the original assignment on the Gender Gap failed to provide the desired introspection and increased levels of awareness in UTC students. Given the troubling nature of student attitudes and comments, a single assignment is unlikely to be sufficient to significantly change student attitudes. However, a more extensive Problem Based Learning assignment is currently being developed for inclusion in the Spring 2014 course offering.

### Problem Based Learning

Problem Based Learning (PBL) is a learner-centered educational approach, which shifts the focus of education to empowered students conducting self-directed learning. In this methodology, the "learner is mentored and encouraged to conduct research, integrate what is learned, and apply that learning to develop a viable solution to an ill-defined problem." [8] Problem Based Learning has been in use in medical education in the U.S. for over thirty years, and has been adopted in many other disciplines, including engineering. Some characteristics of PBL are

- Students ...have the responsibility for their own learning.
- Problems ... must be ill-structured and allow for free inquiry.
- Collaboration is essential.
- What students learn during their self-directed learning must be applied back to the problem with reanalysis and resolution.
- A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned are essential.
- Self and peer assessment should be carried out at the completion of each problem ....[8]

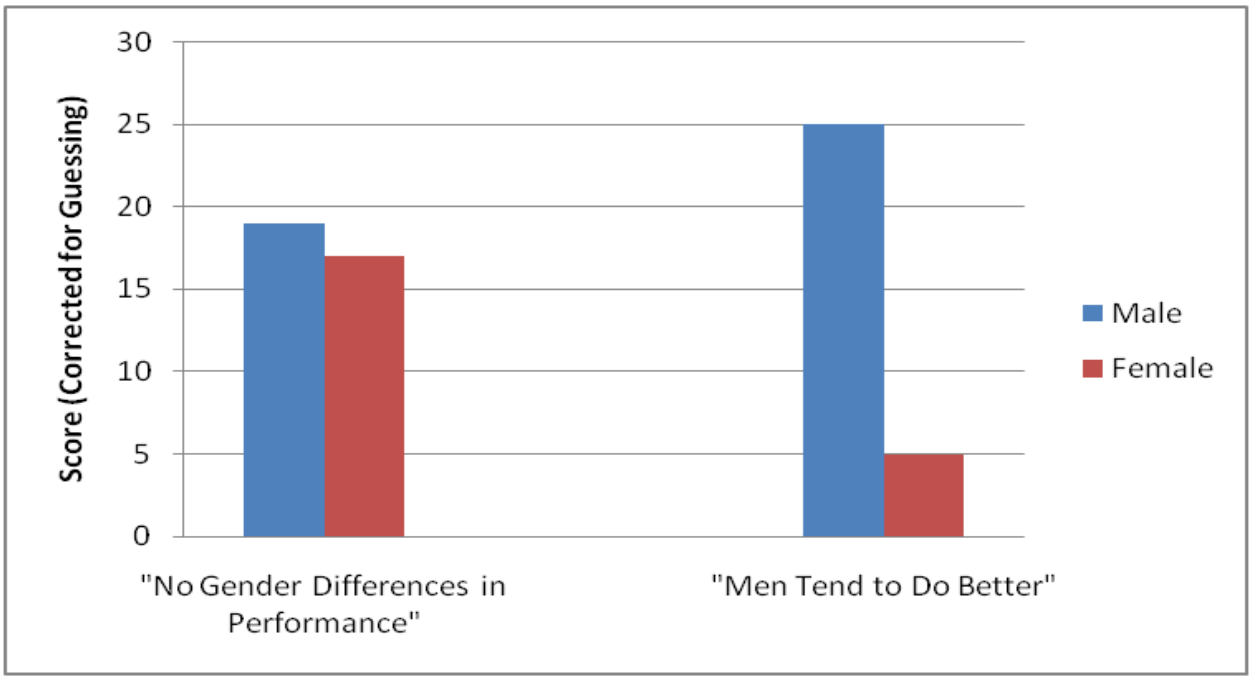


**Figure 3 Performance on tasks based on expectations [2]**

The problem of under-representation of women in technical fields certainly fits well the criteria of PBL, in that it is both complex and ill-defined. Further, the many aspects of the problem would require research of multiple kinds and would make collaboration essential. The new PBL version of the Gender Gap assignment is currently under development, but the current draft is below.

**The New Assignment**

- You will be investigating the Gender Gap in Computer Science, Engineering, and Science in groups of five.
- Your goal is to determine whether the Gender Gap in technical fields is really a problem, and if so, how to fix it.
- Possible causes for under-representation you should address include:
  - Lack of ability of women to excel in these areas
  - Lack of interest and/or information about STEM fields
  - External bias and/or lack of support
- Your research on the topic should include:
  - Demographics, government studies, etc.;
  - Interviews with local businesses and women currently in technical fields;

    - Relevant current events.
- Additional questions you should address are:
    - Are we ethically compelled to address this issue?
    - What can, or should, be done?
- Each group will give an oral presentation of your findings.
- Your individual grade will be based on your classmates' evaluation of your team's content and presentation, and your team's assessment of your personal contribution to the project.

This assignment will be used for the first time in Spring 2014.

## CONCLUDING THOUGHTS

The Gender Gap in technical fields is an extremely complex problem. The use of the Gender-Science Implicit Association Test in the UTC Computer Ethics course, rather than raising awareness as planned, brought to light troublesome attitudes on the part of current students. If, as claimed in [7], men who enter STEM fields are likely to have stereotyped ideas related to roles of men and women in these areas, simply increasing the number of women entering programs will not be sufficient to affect significant change: in addition, attitudes of male students must be addressed.

Though a work in progress, the proposed Problem Based Learning assignment will give an opportunity for both male and female students to explore multiple possible reasons and solutions to the under-representation of women, perhaps affecting their own previously held views of male and female roles in STEM fields in the process. Other possibilities to form a stronger community of female students, such as having female faculty take a group of female students to the First National Women in Cybersecurity Conference in 2014, are being considered.

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