

# How Did Mathematics and Accounting Get So Many Women Majors? What Can IT Disciplines Learn?

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## ABSTRACT

Enrollment of women in Information Technology (IT) disciplines is shrinking. Disciplines that were traditionally male, mathematics and accounting, have succeeded in gaining equal numbers of male and female students. This paper looks at the changes in these two disciplines to see whether similar changes might be used to attract and retain women students in IT disciplines. An overview of the gender transformation of Math and Accounting provides a list of shared strategies used to attract women. A comparison of the three disciplines provides insight for attracting women to IT.

## Categories and Subject Descriptors

K.3.2 [Computing Milieux]: Computing and Information Science Education – *information systems education*.

## General Terms

Management

## Keywords

Women in IT, women in computing

## 1. INTRODUCTION

Twenty-five years ago, the IT discipline had a better representation of women than it does now. Data from the IES National Center for Education Statistics (Table 1) shows a large decline in the number of women receiving bachelor's degrees in computing in three computing disciplines. In computing, women are also underrepresented as content creators. Women make less than 15% of the contributions to Wikipedia (Cohen 2011), and men create most of the channels on YouTube.

There is a shrinking pool of women in the IT labor market. In 1991, women were 36% of the IT workforce. By 2008, the percentage of women working in IT declined to 25% (Ashcraft and Blithe 2009). The department of labor projects 1.4 million job openings by 2018 in computer related jobs. The decline in the numbers of computing majors may create a labor shortage in IT. Companies seeking an educated workforce may have difficulty finding qualified men and women in the future.

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IT is not the first discipline to be described as male-dominated and exclusionary of women. Mathematics and Accounting are also fields with traditionally male-oriented histories. These fields have transformed themselves into disciplines where women are equally represented (Table 2). Did these disciplines do something special to produce positive trends in the numbers of women seeking undergraduate degrees? Are there things that Mathematics and Accounting did to attract women that the IT discipline could adopt?

**Table 1 Undergraduate Degrees Awarded in Specific Disciplines in Computing**

	1987/88		1998/99		2008/09	
	M	F	M	F	M	F
Computing and Information Science	68%	32%	73%	27%	82%	18%
Management Information Science	58%	42%	61%	39%	74%	26%
Computer Science	*	*	*	*	88%	12%

\*values for CS were combined with C&IS for these years.

**Table 2. Number of undergraduate majors in Mathematics and Accounting**

	1992/93		1997/98		2007/08	
	M	F	M	F	M	F
Math	52%	48%	51%	49%	58%	42%
Accounting	46%	54%	43%	57%	47%	53%

1973 Female Math Majors passes 40% (Bressoud, 2009)  
1977 28% of Accounting Majors were Women (Reigle, 2009)

## 2. WOMEN IN MATHEMATICS

The first woman to earn a PhD in mathematics in America was Winifred Edgerton in 1886 (Riddle 2010) from Columbia University. A report from The American Mathematical Society (Loftsgaarden and Watson 1997) shows the growth in numbers of women graduates in Mathematics and Statistics since 1974 (Table 3). However, in 1973, the number of women seeking math degrees was 40% (Bressoud, 2009). The table also shows that the

number of math majors dropped dramatically in the late 80's and then recovered later.

By 1989, a shift in the numbers of women in math had occurred. This was a time when the Windows Operating System was invented (1984) and when the American economy was doing very well. Defense Companies were highly funded and finding math and engineering majors to fill the jobs was a priority. By the early 1990s, the number of women majoring in math was about equal.

**Table 3. Number of Bachelor's Degrees in Mathematics at 4 Year Colleges**

Year	1974-75	1979-80	1984-85	1989-90	1994-95
Math Total	24181	13906	19237	19380	20154
Math women	NA	NA	NA	8847 46%	9061 45%

A wide body of research describes the multiple strategies used to attract women to the mathematics discipline. These strategies can be grouped into three major categories: education, support and alliance.

Education

- K-12 Education
- Changes to Curriculum
- Special programs for women

In the late 70's and early 80's, articles such as "Helping Able Young women Take Math and Science Seriously in School" (Cassery 1979) or "The Study of Social Processes That Inhibit or Enhance the Development of Competence and Interest in Mathematics among Highly Able Young Women" (Fox 1982) appear. There is steady stream of research, spanning over 40 years, about what can be done to make younger women consider mathematics as a college major or professional career choice.

Other articles recommend making changes to curriculum so that courses include content with more context and focus on social values. Many schools created programs specifically to educate and encourage women to go into STEM (Science, Technology, Engineering, and Math) fields in college. For example, girl only science summer camps became available at many universities.

Support

- Creation of an Empowering Setting
- Providing Female Role Models
- Building relationships with Faculty and mentoring
- Grants/Scholarships/Awards & Recognition

Maton (2009) describes the 'creation of an empowering setting'. The Meyerhoff Scholarship Program at the University of Maryland created a culture that supported minorities and women by working hard with all constituencies to create an atmosphere where underrepresented groups felt welcome and respected. What Maton described as working towards 'inclusive excellence', creating an environment where all people "see themselves as important parts of the community, both respected and supported." (Maton 2009)

Other commonly cited support strategies are providing female role models (Heubner 2009), and faculty and industry mentors (Wiest 2009). Grant and scholarship programs for women interested in mathematics are available to gifted women. For example, corporations such as Intel and associations such as the Association for Women in Mathematics and the Society of Women Engineers (with IBM) offer scholarships.

Alliance

- Alliances with Other Disciplines
- Alliances with Industry
- Organizations and sub-organizations

Organizations like the American Mathematical Association and the Association for Women in Mathematics play an active role in encouraging women in PhD programs and in faculty professional development. Organizations specific to women and national organizations that make the inclusion of women a priority changed the disciplinary culture to be more inclusive. Today, the discipline actively continues to work on the inclusion of women with such events as knitting circles at national meetings.

Building alliances with other disciplines is another way to increase women's representation. For example, offering bachelor's degrees in Mathematics Education improves elementary math education and attracts women interested in education to the mathematics discipline. In the 1995 CBMS Survey (Table 4), the numbers of women in Math Education significantly boosted the percentage of women earning math degrees (Loftsgaarden 1997).

**Table 4. Undergraduate Degrees Earned in Mathematics, Math Education and Statistics (1995)**

Bachelor's Degrees	Men	Women	Total
Math	3358	2482 (42%)	5840
Math Education	645	930 (73%)	1275
Statistics	17	6 (26%)	23
Total Math		3418 (48%)	7138

**3. WOMEN IN ACCOUNTING**

Accounting is a very old profession dating back to ancient cultures. The American Institute of Certified Public Accountants (AICPA) was founded in 1887. The first doctorate in accounting was awarded to a Catharine de Motte Greene Quire in 1937 by the University of California, Berkeley (Moonitz, Doyle and Grether 2010).

Some universities did not allow women to major in accounting (Lasseter 1946). Women, who earned accounting degrees held jobs as bookkeepers because firms would not hire them as CPAs. As early as 1900, 29% of all bookkeeping positions were held by women (Wootton and Spurll 1994). By 1940, there were 16,000 CPAs, and only 175 of them were women. It wasn't until World War II, when male accountants joined the military, that a significant labor shortage forced large firms to hire women (Wootton and Spurll 1994).

During the World War II labor shortage, firms began hiring women away from bookkeeping jobs. Firms like Price Waterhouse & Co. would recruit women graduates in accounting

and offer training to women recruits (Allen and McDermott 1993).

Wescott and Seiler (1986) report that the greatest opportunity for women during WWII in accounting was with government agencies. The pay was lower but the acceptance into the field was much greater at government agencies than in private industry. After the war and today, there continues to be a trend of women working for smaller firms where the opportunities for advancement to upper levels of management are more favorable to women (Reigle 2009).

In 1977, 28% of accounting majors were female (Reigle, 2009). Today, there are more women accounting majors than men. Like math, the number of Accounting degrees awarded decreased in 2000-2001 (Billiot, Glandon & McFerrin, 2004), partially because of a requirement for 150 credit hours of study to become a CPA.

#### Education

Articles about women accounting majors tend to look at differences between men and women and their approach to ethics or other problems. Writings about women accounting undergraduates discuss ways that universities have social structures that do not encourage women, such as lack of female role models or women's representation in accounting textbooks (Tietz, 2007). However, much of the research on women's equity in accounting focuses on the profession.

#### Support

In the literature, support strategies are apparent in studies about women at work. Even though an equal number of women go into accounting, their representation at the partner level is only 18% (Reigle 2009). Research about work-life balance, retaining women in the profession and changing corporate culture is plentiful (Doucet and Hooks 1999). The need for women accounting faculty as role models was also studied as the numbers of women accountants in industry grew faster than at the university.

#### Alliance

The American Society of Women Accountants was founded in 1938. It and the AICPA have scholarships and special programs for women, including retaining women and promoting women to higher levels of management. Major accounting firms, such as Deloitte and KPMG, have institutionalized programs to support women.

## **4. WOMEN IN IT**

The University of Wisconsin, Madison awarded the first PhD to a woman in computer science in 1965, Sister Mary Kenneth Keller.

Table 1, shows the decline in enrollment of women in computing disciplines.

In 1991, Ellen Spertus examined the problem of so few women in computing. At the time, 30% of the undergraduate women in the country were computer science majors. Spertus gave detailed descriptions of stereotyping, subtle bias and the masculine computing environment. The report concluded that the underrepresentation of women was due to subconscious behavior that discriminates against them. Spertus also gave several recommendations such as development of policies and programs that encourage women and examples of how women could successfully react to biased behavior.

Tracy Camp (1997) showed how girls and women abandoned computing studies at many levels of education, also showing that if a CS degree was in a College of Engineering, the number of graduates was lower, the 'Engineering Effect.' Camp's (2002) prescriptions for improving the numbers of women include friendlier learning environments, early computer education for girls, teacher education and to actively promote capable women.

#### Education

CS enrollment has declined in general, not just for women. The Computing Research Association reports two enrollment dips at doctoral granting institutions (Vegso, 2007). The first was in the late 1990s, after which enrollment grew until 2000. From 2000 to 2006, undergraduate CS enrollment dropped by 50% (Manaris, 2007). Many attribute the drop in enrollment to the .com bust.

To attract students back to IT, early education programs using languages such as Alice or Scratch have been implemented. Harvey Mudd College reports increasing women in CS by adopting Python as the introductory language, and by splitting classes into groups of experienced and non-experienced programmers (Alvarado and Dodds, 2007). They also created opportunities for first-year women to participate in CS research and to attend the Grace Hopper Celebration of Women in Computing.

Research indicated that women were more interested in courses that were contextualized and in which they could see the positive social impact computing could have. A handful of Universities changed their curriculum to offer more courses focusing on the application of computing to real problems earlier in the curriculum. These programs have had some success in increasing the numbers of women (Blum and Frieze 2005). Other programs focused on computing applications using interdisciplinary courses (Beck, Buckner and Nikolova 2007).

#### Support

Support programs for women in computing are well documented. The National Science Foundation has funded summer camps in computing and programs that encourage female faculty members in IT to be role models to their students and leaders at their Universities.

Many prescriptions for attracting women to computing indicate the need to change classroom and work environments that are socially alienating to women (Camp, 1997). Spertus (1991), gives several concrete examples of how women can deflect or mitigate bias attitudes through humor or indirect language. In so doing, a woman is prepared for what may be a socially uncomfortable classroom or workplace.

Many universities provide female faculty role models and mentors. Grants and scholarship programs promoting women are available through universities and organizations.

#### Alliance

Numerous organizations have an interest in increasing the numbers of women both academically and professionally (ex. ACMs Committee on Women in Computing, National Center for Women and Information Technology).

Even though IT disciplines are active in the same types of activities as accounting and math, these efforts have not translated into higher enrollment of women in computing majors.

During the 70's and 80s, women went into computing because it was reputed to be a new field in which women had an equal

chance of succeeding. To fill the industry shortage, programs were created to retrain women professionals to work in computing. Women in lower-paying, lower-status jobs saw this as a good career move. Yet, today there are fewer women in computing majors and in IT jobs.

## 5. DISCUSSION

Love it or hate it, students are required to do math from kindergarten to college. Math is used in a wide variety of subjects such as physics, finance and computing, so students see that math is rudimentary to attaining higher knowledge. Also, there is a public sense that having math skill will lead to a higher paying job in the future. Math skills are systematically tested in K-12 education, showing that girls are as good at math as boys. This has helped to reduce bias in perceptions of girl's ability to do math. There is no genetic reason that women should not succeed in math careers. The career path for mathematics is very diverse, giving women plenty of options in different industries. In addition, the numbers of women seeking undergraduate degrees increased greatly when mathematics education was included as an option. Computing is consumed in the lives of every high-school and college student. High school students are likely to use mobile applications, Moodle supported coursework, spreadsheets for science and math, and word processing, of course. Students are also savvy with virus protection, music piracy, wireless connections and Skype. While most high school students do not learn programming, they are already somewhat knowledgeable of computing. In college, programming is required by several disciplines such as cognitive science, accounting, math and astronomy. With so few women in IT, undergraduate women can feel like they do not have what it takes to succeed in computing, especially if programming is new to them and they are in courses where men have more experience and confidence. There is still a large held belief that genetically, women are not a good fit with IT.

IT might learn from math by developing options in computing that attract women. For example, marketing has large numbers of women and is a technology driven field. Offering an option in Marketing Technology could help to attract female students. Alliances with graphic design or educational technology offer other possibilities.

Accounting, though not part of the K-12 curriculum, is a well-defined discipline. It has a set of exams to measure qualifications that show women's capabilities. The profession also has well-defined career paths. Part of the undergraduate Accounting experience is becoming knowledgeable about the profession. Strength in the profession often drives curriculum and many Accounting faculty are also licensed CPAs. Accounting is also a profession that has a good job outlook, with high-paying careers for graduates.

IT is a discipline that is much less defined. If someone says they are an accountant, everyone has an understanding of what that might be. If you meet an IT professional, that could mean many things. They might be a programmer for a pharmaceutical company, a help-desk employee for best buy or a hacker for the National Security Agency. Broad lack of understanding of what IT is keeps students away from selecting IT disciplines for undergraduate majors.

The only exam that systematically measures computing skill of college bound students is the AP exam in computer science, that few women take. There is a common belief that women are not

suited to be programmers. Women, facing a discipline where they are outnumbered by men and less knowledgeable often come away from a first programming course agreeing that IT is not a fit for them.

Comparing Math, Accounting and IT, it is clear that all three disciplines do similar things to build a welcoming environment for women. All have professional groups with women's issues on the agenda. All have mentoring programs, opportunities to see women in industry and female faculty role models. Differences in the disciplines exist but, the approaches to supporting women are similar. Two areas that stood out as things that IT was not doing are 1. building alliances and options that might be interesting to women and 2. defining IT and associated career paths in a way that pre-college students can understand.

## 6. CONCLUSION

Many authors have given prescriptions for attracting women to computing (Spertus, 1991; Camp, 1997; Alvarado & Dodds, 2010). The most commonly cited way to increase the numbers of women in computing is to change the culture of IT. Educational, support and alliance strategies have helped to create friendlier environments for women in accounting and math departments. However, for IT the change has not occurred even though we have had 20 years to work on this problem.

Certainly, IT programs will continue to *work to build cultures where everyone* is welcome. As a discipline, IT knows the enrollment for women and minorities in computing is a problem that it needs to work on fixing locally and nationally. However, if no one comes to IT, they cannot enjoy the warm environment we've created.

IT needs to *build alliances with other disciplines* to increase the numbers of women in IT. Math is an obvious alliance for IT. Other disciplines, with high female enrollment could prove successful in attracting women. An interdisciplinary degree in Marketing, an increasingly IT intensive discipline, could interest more women and men to IT. This could also have a positive effect on job placement for these students.

Computer Science is listed as the second top-paying job for a new college graduate in 2011 (Madden 2011). The US Department of Labor Bureau of Labor Statistics reports that of the 10 occupations with the most new jobs in 2002-2012, 6 of them are in IT.

The IT discipline is highly diverse, with many career paths. When a student asks what their career might be, the answer is not quick and simple. It is difficult for pre-college students to see a set career path, unless their parents are employed by the IT industry.

Changes in student perception of what IT careers are could greatly transform IT education and industry. But, to gain the mass understanding of what IT is, computing needs to be promoted to both men and women.

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