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# Gender, Software Design, and Occupational Equity

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## Abstract

After reviewing the work on gender bias in software design, a model of gender-role influenced achievement choice taken from Eccles [7] is presented. The paper concludes that (1) though laudable, reduction of gender bias in software design is not the most straightforward way to reduce gender inequity in the choice of computing as a career, (2) the model itself makes more clear some of the ethical issues involved in attempting to achieve gender equity on computing, and (3) efforts to reduce gender inequity in the choice of computing as a career need to be evaluated in the light of this model.

## Introduction

The author spent the summer of 1984 as a member of the research staff at Bell Labs in New Jersey, helping people there think about the social psychological aspects of human-computer interaction. As a part of that project, we designed a study to demonstrate that social expectations can influence the design of software. We wanted to show that the design of a piece of software was, in part, influenced by the designer's social stereotypes of the user. My original study involved having programmers design software for secretaries and in turn, having secretaries design software for programmers. But Joel Cooper, one of my supervising professors convinced me that we should capitalize on the implicit gender stereotyping (secretaries vs. programmers) in the study and look at gender stereotypes in educational software. Thus was born a decade and a half long research program on gender and computing.

What we have learned during this time is more complex than the original idea that gender stereotypes (and presumably other stereotypes too) influence software design. Certainly, it is true that software design is a social process and that gender stereotypes can infiltrate the design. But the effect these design decisions have on users is more complex and is embedded in the social worlds of those who use the software. This short paper will review some of this complexity, with the goal of presenting a conceptual structure of how boys and girls make occupational choices.

## Gender Stereotypes in Software Design

We know that our social stereotypes, when they influence our actions towards others, can produce what is called a "self-fulfilling prophecy." For example, Word, Zanna, and Cooper [16] first tracked the different ways that white interviewers behaved toward black and white job candidates. They then had other interviewers adopt these two different

styles in a series of interviews with white candidates. Those white candidates who were interviewed with the style taken from interviews of black candidates performed less well in the interview than did those interviewed with the style taken from interviews of white candidates. Thus, the way the interviewer behaved disadvantaged black candidates; one could attribute their poor performance in the earlier interviews to their reaction to the interview style rather than to their race.

Likewise, we might expect that those who use software designed for the "other gender" (boys using software designed for girls and girls using software designed for boys) would experience some conflict with the expectations the software had of them (e.g. their interests, aptitude, etc.) and might perform less well when using that software. To test this analogue to the interview situation, we needed to discover first what software designed for boys and girls looked like and then to have boys and girls use that software.

We had teachers design educational software either for boys, girls, or (gender unspecified) "children" [9]. The programs were to teach students how to use commas in sentences. We gave the designers simplified questions to prompt a rough specification of the program they were designing (e.g. What will the theme of the program be (a trip, a conversation, a quiz, a game)? How will the child interact with the program (through typed commands, a menu, a joystick, etc.)?). We then had the designers and independent raters rate those programs in terms of characteristics like time pressure, verbal interaction required, control given the user, etc. We found that programs designed for boys looked like games (with time pressure, eye-hand coordination, and competition most important), while programs for girls looked like "tools" for learning (with conversation and goal-based learning). A representative "boy" game had the students shooting commas into sentences, under time pressure,

with a “comma cannon.” A representative “girl-learning tool” was a simple drill and practice program. Thus, we now had the prototypical “boy” and “girl” software profiles.

In addition, programs designed for (gender unspecified) “children” looked just like those designed for boys. This confirms the idea that gender-based stereotypes can unintentionally influence the design of software. Programs designed for “students in general” were really programs designed for boys. Interestingly, 80% of the designers of our programs were female, many of whom expressed concern that educational software was male-biased. Thus, even well-meaning, female educators subtly and strongly weave our gender stereotypes into software. We will return to this subtle but robust influence of gender stereotypes later.

However, what happens if we ask boys and girls to use these two different kinds of software? Do these differences in program design actually result in different outcomes for students using the programs? In order to test this, we chose female- and male-oriented programs [6] according to criteria corroborated by the Huff and Cooper [9] research. The male oriented program involved competition and shooting whereas the female oriented program used music, verbal feedback, and tasks that required completion. Middle school students then used these mathematical programs in both a private setting (an isolated individual carrel) and a public setting (a computer lab with others present). We found that students using software designed for the other gender reported more situational stress than when using gender specific software. However, this cross-gender software-induced stress occurred *only when the software was used in the public setting*. When the software was used in private there were no differences in situational stress levels. Thus, we found the cross gender-stress effect we had anticipated, but discovered that it was linked to public performance.

The fact that the cross gender-stress effect only occurred in public emphasizes even more strongly the social nature of human-computer interaction. Thus, the designer of the program provides one social context of computing, but another important social influence on computing comes from the situation in which the person uses the software. In addition, both of these together can influence an individual’s sense of success when using a computer.

So far, then, we have learned that gender stereotypes can make their way into the design of software, and that software that is based on those stereotypes can differentially affect boys’ and girls’ experience of interaction with the software. However, there is a complicating factor too: this influence only occurs when one uses the software in public.

### The Importance of Expectation

In an attempt to understand this complicating factor, Robinson-Steveley and Cooper [13] conducted two studies to examine the effect of the presence of other people on performance in a computing task. They found that when women (college students in this study) used a computer in the presence of another person, they reported higher levels of situational stress and performed less well than when they did

the same task in private. In contrast, when men completed the computer task in public, they performed better and reported significantly lower levels of situational stress than they did in private. Both these effects occurred only among computing novices; irrespective of gender, experts were unaffected by the presence of others.

A second study proposed an explanation for this effect: Perhaps the differential expectations of success or failure produce the gender differences in reaction to the presence of others. In the second study, men and women were asked to do the same computer task in either public or private, but some were told that the task would be very difficult for them. Others were told that the task would be quite easy for them. No gender differences or instructional set differences occurred when they did the task alone (replicating study 1 and [6]). In addition, no gender differences were found in the public condition. However, there were differences in the public performance condition based on expectations. Those expecting success performed better in public than in private, whereas those expecting failure performed worse in public. Thus, study 2 was able to eliminate the public performance gender difference by manipulating expectations of success or failure.

This suggests that the gender differences are, in fact, a function of gender-based expectancies of success or failure. Perhaps when an individual expects failure - and there are others present to witness this failure - arousal is produced that interferes with performance [2, 3, 5]. In the Cooper, Hall, & Huff study [6], when boys used “girl” software in public and when girls used “boy” software in public they both felt more stress, likely because they both felt they were doing a task that was not a good fit, in the presence of others who could watch them fail.

### Matching Expectancies with Career Choice

So the effect of gender stereotyped software depends on the match (or mismatch) of the software with the user’s gender role, but only becomes important when the mismatch occurs in a public setting, thus threatening public failure. This short description of the effects we have found brings to the fore the importance of gender role appropriate behavior and peer influence in the process. This is important to emphasize, since gender roles are ubiquitous in their influence on men’s and women’s experience with, and career choice in, computing.

Jacquelynne Eccles provides the most comprehensive model of the influence of gender role on career choice [7]. Figure 1 shows a simplified version of Eccles’ model, concentrating on two items (*expectation of success* and *subjective task value*) that are weighed together to form achievement related choices.

We should first note that both of these two items are heavily influenced by the personal goals and self-concept of the person making the choice. What the person values, both long and short term, how they perceive themselves and their own abilities, and how they think of who they ought to be are all strong influences on *expectation of success* and *subjective task value* which in turn influence achievement choices.

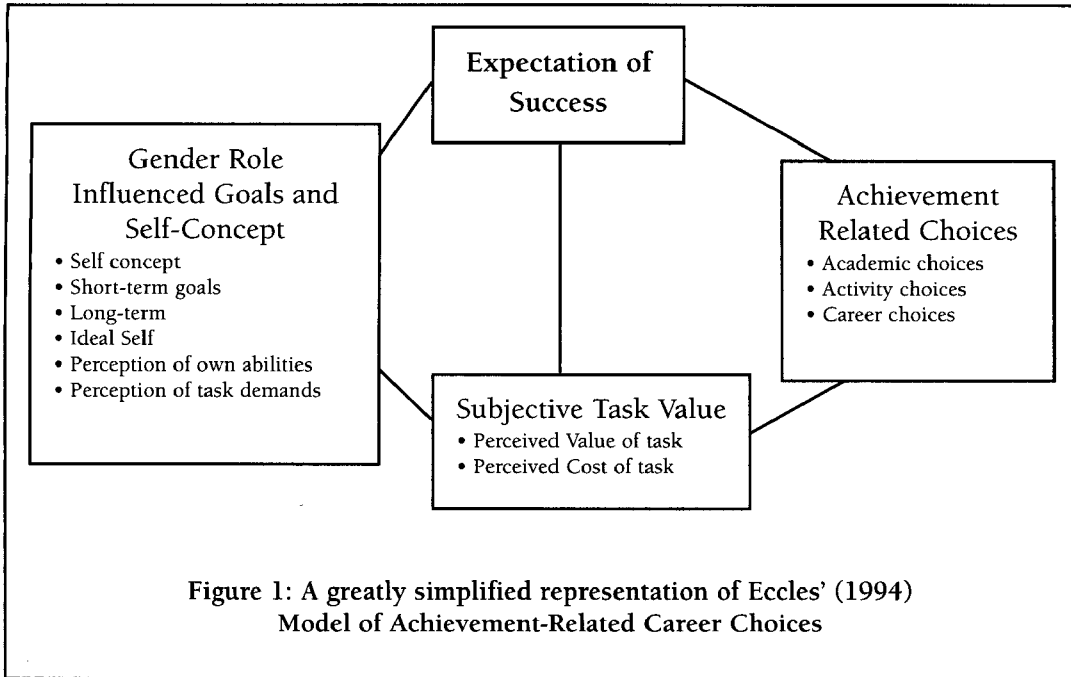


Figure 1: A greatly simplified representation of Eccles' (1994) Model of Achievement-Related Career Choices

The author is not aware of data documenting this, but the trends mentioned above may also lead to a narrowing of gender differences in expectations of success or failure in computing.

**Subjective Task Value**  
The perceived value of the task to the person depends on an additional match: The match of the person's own values with the perceived values the task supports. Science (outside of medicine) is usually perceived as a task that isolates the individual and involves competitive

And how the self is construed is also heavily influenced by external factors like cultural stereotypes of gender role and occupations, peer and parental influences, and previous achievement experiences. I have not included all the "external" influences on the person's choice, though they can be found in the full Eccles model [7]. The full model and the portion we are concentrating on here have received strong empirical support from a wide range of studies of influences on boys' and girls' career choices (see [15] for a review).

**Expectation of Success**

People choose achievement situations (whether it be using software in public or choosing a career) in which they think they can succeed. Their estimates of likely success in an achievement situation are based on their expectations of the match of their ability to the demands of the task. Estimates of both their ability and task demands can be influenced by gender role expectations. What are boys and girls good at or supposed to be good at (ability)? What does it take to make a good doctor or computer scientist (task demands)? These expectations of success directly influence career choice and other achievement choices. But, they also influence achievement choice indirectly through their influence on subjective task value: how much do I value this career (in which I might well fail)?

Expectations of success are likely to be the most easily addressed of the two influences in terms of gender bias. It is clear that gender differences in verbal and math ability are shrinking, and are now so small that they are unlikely to be detectable in everyday life [10]. Gender based expectations have begun tracking these diminished differences [1]. We are, then, less likely to be seeing girls who expect failure in math and avoid math in middle school because they might fail. This will increase the pool of mathematically sophisticated women who might be recruited into computer science.

achievement on abstract problems. Engineering (and computer science) are perceived similarly, though perhaps more isolating. Do these task stereotypes match their own values? To the extent that they do (and are not offset by high perceived costs), the task will have high subjective value.

It is here, in subjective task value, that computer science may have the most difficult time in achieving gender equity. Changing girls' stereotypes of the field is a straightforward approach, and likely to yield some promise. Some headway in changing task stereotypes might be made by mentorship programs in which girls are encouraged to learn about the field of computing from women already in the field [14]. But, changing the subtle and strong gender role expectations for boys and girls in the population is a larger task and not likely to produce any quick progress in gender equity in computer science.

**An Ethical Aside**

Deborah Johnson and Keith Miller (See [11] in this special issue) provide a look at a central ethical issue involved in gender equity in computer science: Are jobs in the field unfairly constituted in a way that discourages women from participation? The model presented here has implications for that discussion. This is not a model of how computer science has included job criteria that are distasteful for women. It is instead a model of how men and women are reliably, subtly (and not so subtly) influenced to value different career paths in our culture. These different valuations can then result in different work environments, based on the preferences of those who inhabit the field. Central ethical questions then become more clear: to what extent and in what manner are these choices constrained? What is legitimate vs. illegitimate influence? Can a set of individually correct career choices (based on matching of values with career) still result in an inequitable gender distribution of careers? If so,

might we still want to say there is something unfair about a socialization process that guides and supports these individual career choices?

### Back to Software

We know now that software design can carry social values, can influence the behavior of others, and may even contribute to influences on career choice. What might be the answer to this difficulty? Can we design software that we know does not incorporate inequitable gender stereotypes?

Some companies (e.g. Girl Games, Purple Moon, etc. see [4; 8]) have designed educational software that legitimizes and exploits gender differences in order to entice and involve girls into computer use. I know of no research that has been done to evaluate the effect of this sort of software on children's career choices. Our model suggests that we should look for the effect not only in how it influences achievement related choices, but also in how it reinforces the girls' gender-based self concept and the match with the subjective task value associated with different careers. Software that supports traditional gender roles may give girls experiences of success with computers, but this benefit may be offset by the support it gives to traditional gender-based subjective task values. It may thus give with one hand and take away with the other.

If we want to design software that avoids these stereotypes, can we? Work in human computer interaction suggests we can. Landauer's work on user centered design, development, and deployment [12] shows that expert reviews or user testing can help to eliminate many human computer interaction flaws in software. I suspect that, particularly with software for children, we could add a criterion of reducing gender bias to this review and find ourselves successful in doing so. Would it help?

The outcome depends heavily on the context in which the software is used. The influence of peers, parents, and the social context on gender roles is unlikely to go away. It would certainly be a good thing to eliminate gender bias in software design. The effects of doing so would have to be evaluated in the context of the model presented here. In the social context in which the software will be used, will it decrease gender differences in expectations of success and in subjective task value? The answer is likely: not by itself, particularly given the social context in which the software will be used. Therefore, we will also need to work within the parameters of the model to reduce gender inequities in career choice more directly.

### References

[1] Anderman, E.M.; Eccles, J.S.; Yoon, K.S.; Roeser, R.; Wigfield, A; Blumenfeld, P. (2001). Learning to value mathematics and reading: Relations to mastery and performance-oriented instructional practices. *Contemporary Educational Psychology*. 26, 76-95.

[2] Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology*, 46, 610-620.

[3] Baumeister, R. F., Hamilton, J., & Tice, D. (1985). Public versus private expectancy of success: Confidence booster or performance pressure? *Journal of Personality and Social Psychology*, 48, 1447-1457.

[4] Beato, G. (1997). Girl Games. *Wired*. Retrieved December 27, 2001 from: [http://www.wired.com/wired/archive/5.04/es\\_girlgames.html](http://www.wired.com/wired/archive/5.04/es_girlgames.html)

[5] Cooper, J., & Hall, J. (in press). Gender, experience, and attributions to the computer. *Journal of Educational Computing Research*.

[6] Cooper, J., Hall, J., & Huff, C. W. (1990). Situational Stress as a consequence of sex stereotyped software. *Personality and Social Psychology Bulletin*, 16, 419-429.

[7] Eccles, J.S. (1994). Understanding women's educational and occupational choices: applying the Eccles et al. Model of achievement related choices. *Psychology of Women Quarterly*, 18, 585-609.

[8] Gorriz C. & Medina, C. (2000), "Engaging Girls with Computers Through Software Games", *Communications of the ACM*, 43, 42-49.

[9] Huff, C., & Cooper, J. (1987). Sex bias in educational software: The effect of designers' stereotypes on the software they design. *Journal of Applied Social Psychology*, 17, 519-532.

[10] Hyde, J.S., Fennema, E., & Lamon, S.J. (1990). Gender difference in mathematics performance: A meta-analysis. *Psychological Bulletin*, 107, 139-155.

[11] Johnson, D. & Miller, K. (2002) Is diversity in computing a moral matter? *inroads (SIGCSE Bulletin)* 34(2).

[12] Landauer, T.K. (1995). *The trouble with computers: Usefulness, usability, and productivity*. Cambridge, MA: MIT Press.

[13] Robinson-Staveley, K., & Cooper, J. (1990). Mere presence, gender, and reactions to computers: Studying human-computer interaction in the social context. *Journal of Experimental Social Psychology*, 26, 168-183.

[14] Single, P. B. and Muller, C .B. (2001). When email and mentoring unite: The implementation of a nationwide electronic mentoring program. In L. Stromei (Ed.), *Implementing successful coaching and mentoring programs* (pp. 107-122). Cambridge, MA: American Society for Training & Development (ASTD) In Action Series.

[15] Wigfield, A., & Eccles, J. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology. Special Issue: Motivation and the Educational Process*, 25, 68-81.

[16] Word, C. O., Zanna, M. P., & Cooper, J. (1973). The nonverbal mediation of self-fulfilling prophecies in interracial interaction. *Journal of Experimental Social Psychology*, 10, 109-120.