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AUTHOR	Raphael, Chad
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ABSTRACT

This paper identifies three rationales in the relevant literature for closing the gender gap in computing: economic, cultural and political. Each rationale implies a different set of indicators of present inequalities, disparate goals for creating equality, and distinct principles for software and web site design that aims to help girls overcome the gender gap by increasing their interest and knowledge about computing. It is suggested that designers should pay greater attention to the political rationale for equity, conceiving software and Web sites that cultivate girls' civic uses of computers, so that women can exercise equal control over the architecture and policy of the information age. (Contains 28 references and 2 figures.) (Author/AEF)

"Citizen Jane": Rethinking Design Principles for Closing the Gender Gap in Computing

Chad Raphael
Santa Clara University
United States
craphael@scu.edu

Abstract: This paper identifies three rationales for closing the gender gap in computing – economic, cultural and political – in the relevant literature. Each rationale implies a different set of indicators of present inequalities, disparate goals for creating equality, and distinct principles for software and web site design that aims to help girls overcome the gap by increasing their interest and knowledge about computing. It is argued that designers should pay greater attention to the political rationale for equity, conceiving software and web sites that cultivate girls' civic uses of computers, so that women can exercise equal control over the architecture and policy of the information age.

In the recent literature on the gender gap in computing, arguments for pursuing greater equity among males and females may be urged for economic, for cultural, or for political reasons. Each rationale is significant, and often they are entwined in practice, but they are worth disentangling because each suggests different goals for achieving equity, distinct measures of current inequalities, and disparate design principles for media that aim to help girls overcome the gap. Focusing exclusively on one rationale is likely to obscure designers' understanding of the gender gap and how to address it. This paper compares each strand of thinking, and considers their implications for designing educational and recreational multimedia and hypermedia aimed at attracting girls to computing. Although many reasons have been offered for the gender gap, the lack of suitable software and web sites for girls is often cited as a cause (American Association of University Women 2000; Cottrell 1992; Furger 1998; Schofield 1995). Finally, it is argued here that the political rationale for equity has been neglected and that designers should devote greater attention to fostering the civic uses of computers by girls.

Economic Rationales

Traditional liberal feminist concerns about gender equity in schooling and the workplace underlie economic arguments for ameliorating inequalities of access to, uses of, and attitudes about computers (Fig. 1). Indeed, there is continuing cause for concern about girls' preparation for technical careers, according to the measures employed in this approach. Compared to boys, girls still report less experience with computers (Schumacher & Morahan-Martin 2001), less confidence in their computing abilities (Young 2000), and less interest in the technology (American Association of University Women 1999). In higher education, women's share of bachelor's degrees in computer science declined from a high of 37 percent in 1983 to 28 percent in 1996 (Camp, Miller & Davies 2000) and women earned just 17 percent of the doctorates in the field in 1998 (U.S. Bureau of the Census 2000). In 2000, UCLA's annual survey of first year college students nationwide found that 1.8 percent of women, compared to 9.3 percent of men, said they planned to pursue a career in computer programming, the biggest gender difference since the survey first posed the question in 1971 (Higher Education Research Institute 2001). In the workforce, women hold an estimated 20 percent of information technology (IT) jobs, and are especially underrepresented in systems analysis, software design, programming, and technological entrepreneurship (American Association of University Women 2000).

Arguments for educational and economic equity often lead to calls for software and web sites that feature women role models in the technical professions (e.g., Furger 1998), such as Cascade Pass's *You Can Be A Woman Engineer* CD-ROM or web sites for girls about careers in the field (e.g., www.backyard.org). It is hoped that this strategy will counteract many girls' image of technical work as masculine, dull, sedentary and anti-social (Garnett Foundation 1997), sucking more females into the educational "pipeline" toward higher

Argument	Type of Equity	Gender Gap Measures: Proportion of Females	Design Strategies
Economic	• Educational • Occupational	• In computer clubs, camps • In computer science and engineering classes, degrees • In technical jobs in IT • As equal earners in field • In entrepreneurial leadership	• Role models: corporate technical professionals, managers
Cultural	• Expressive • Aesthetic • Relational	• As internet users • As software consumers • As software entrepreneurs, designers	• Gender-Traditional • Gender-Nontraditional • Gender-Neutral
Political	• Civic	• As decision-makers, framers of computer design, regulation	• Ethics, law • Constructivist, feminist pedagogy • Critical thinking with and about technology

Figure 1: Arguments for Gender Equity in Computing

degrees and jobs in computer science and engineering. However, sole pursuit of the economic rationale can narrow designers' vision in ways that may be counterproductive, even for girls' economic interests. Too often, the range of role models provided is limited to professional and managerial roles in corporate IT settings, where employment is notoriously unstable. Moreover, as computer skills become central to many fields, from medicine and law to auto mechanics, these fields should exert more influence over technology design and uses (American Association of University Women 2000). Even if gender parity in IT jobs were achieved tomorrow, the vast majority of girls (and boys) would not work in this sector. Thus, girls would be better served by media that demonstrate the relevance of computing skills to a broader range of work than systems analysis or programming, which are not the only paths to molding technology and may be rejected by many girls.

The larger problem with the economic argument is that it tends to reduce the goal of technological fluency, indeed of education and play, to vocational training. The rhetoric of "keeping up" or "achieving equality" with males in technical careers rarely encourages girls to question the norms of the high technology workplace or the purposes of technology design. Nor does this approach ask girls to consider how women could transform those norms in ways that might benefit everyone, such as by making high tech careers more compatible with family life. Focus group research suggests girls are not necessarily fearful of computers but disenchanted with a masculine computer culture that they associate with obsessive work, materialistic motives, trivial and unethical uses of technology, and a false sense of control over the world (American Association of University Women 2000). For these girls, appeals to join such a culture that do not acknowledge how it might be changed and why it would be worth making the effort are likely to fall on deaf ears.

Cultural Rationales

Cultural arguments for equity focus on increasing females' opportunities to use and adapt technology to explore and express their identities, create and communicate, and maintain relationships. Here, the gender gap appears to be closing in some ways, according to the indicators used or implied by this approach. Men and women entering college now report that they use computers frequently in almost equal numbers (Higher Education Research Institute 2001) and women have gained parity with men in using the Internet, with teenagers accounting for the fastest growing segment of female users (Hamilton 2000). Women take greater advantage of email to maintain relationships with friends and kin across distance than do men (Boneva, Kraut & Frohlich 2001). In accordance with females' tendency to view the computer as a tool to accomplish tasks rather than an object of interest to be explored in its own right, females are more likely to use computer applications for word processing, graphic design and communication instead of play, programming or systems

design (American Association of University Women 2000). There are more multimedia games designed by women-led companies for girls, although girls still buy only 12 percent of games (Gorriz & Medina 2000).

Cultural arguments emerged in discourse about the gender gap in the 1990s, especially in the debate over how to design multimedia games for girls (see Cassell & Jenkins 1998). One camp appealed to girls' traditional interests in cooperation, collaboration, glamour, bright colors, multiple paths through stories and environments, and so on. This "game girls" strategy suggests that the most effective way to increase girls' interest in computers is to show how the technology can be used to explore conventionally "feminine" activities, endorsing traditional aspects of girls' culture. It is indebted to cultural feminism, which posits a separate women's culture of nurturing and knowing (e.g., Gilligan 1982). This approach extends to web sites for girls that primarily feature information on dating, friendships, shopping and communication.

A second strategy urges girls to become more comfortable playing aggressive games designed for boys, in hopes of fostering girls' assertiveness. The "game grrls," as these teens and young women call themselves, appropriate the formerly male domain of computer games, embracing its images of feminine warriors and potent female sexuality as self-empowering (Wakeford 2000). Game grrls reject constricting images of females as passive victims or supportive helpmates, which they accuse girl games, boy games and prior feminist thinking of perpetuating. From this standpoint, the optimal way to boost girls' interest in computers is not to pursue a separatist design strategy, but to demonstrate the relevance of nontraditional gender interests to girls' lives, appropriate them as legitimately feminine, and beat boys at their own games. The game grrls share "third wave" or postfeminist rejections of earlier feminisms, seen by grrls as "constricting (politically correct), guilt inducing, essentialist, anti-technology, anti-sex, and not relevant to women's circumstances in the new technologies" (Wilding n.d.) The game grrl strategy extends to the web on sites that offer discussion forums and articles on games, sex, and culture.

A third approach calls for creating gender-neutral content based on non-violent interests common to boys and girls. This software may include mystery games (such as Myst) and puzzle games (such as Tetris) that do not feature recognizably gendered protagonists and villains, or that employ characters (including animals) of indeterminate sex. Justine Cassell (1998), one of the foremost advocates of this strategy, has designed software that appeals to boys' and girls' shared interests in self-expression and self-construction by embedding computers in familiar objects such as blankets and stuffed animals that children can use to record and share their own stories. Her games and toys apply feminist pedagogy's call for sharing power more equitably between teacher and student to the relationship of designer and user, and an emphasis on validating and learning from children's own subjective experience. Under this approach, the best way to interest girls in computers is to show their relevance to all children's interests in acting as detective or storyteller, with no intervening protagonists and overt gender preferences with which to identify.

One danger of the cultural approach is its exclusive thinking about how to address girls' identities and gender socialization. Thus far, the debate over game design for girls seems to have been won in the marketplace by gender-traditional advocates, as evidenced by the commercial dominance of *Barbie Fashion Designer* and other "pink software" (Gorriz & Medina 2000), and in academic and policy circles by gender-neutral proponents (see American Association of University Women 2000). However, recent experimental research suggests designers can increase girls' interest in computers, even in programming techniques, by demonstrating their relevance both to girls' non-traditional and traditional interests (Lynn, Raphael, Olefsky & Bachen forthcoming). Approaches that offer a single way of constructing girls' identities, including those that reflect only the interests they share with boys, are bound to feel limiting for some girls.

In addition, cultural rationales require a great leap of faith that girls' use of current multimedia games, regardless of how they construe users' identities, can serve as a gateway to technical skills and careers. Almost none of the current multimedia games foster an understanding of programming, systems or network design, where the gender gap is widest. Rather, they treat computers as a means to design clothes, disembowel aliens, or disclose stories. If we want to introduce girls to what is compelling about working with computers, none of these design strategies reveals much that is compelling about how computers work. If we want girls to have equal opportunity to shape the hardware and software of the future, multimedia design needs to encourage girls more overtly to explore how they might design or adapt the technology and to what ends.

Political Rationales

Political arguments for equity stress the need for women to be fully informed and enfranchised citizens of the information age. This approach suggests that girls and women need to know how technology works to

participate in democratic processes of designing, implementing and regulating what Lawrence Lessig (1999) has called "code." By "code" Lessig means both the design of computer architecture (software, hardware and systems) but also relevant codes of law, policy and ethics. Girls need hands-on experience writing both kinds of code according to this rationale, which surfaces occasionally in policy discussions about technology in education (e.g., Committee on Information Technology Literacy 1999; Alliance for Childhood 2000), but almost never in the literature on gender equity and computing.

Is there a gender gap in the civic aspects of computing? We know far less about this gap than the economic or cultural ones, largely because we have not developed indicators that would allow us to measure its dimensions. Doing so requires thinking about who shapes technology design and regulation within corporations, government, academia and civil society. We could begin by assessing the amount and quality of women's participation in making decisions about code as corporate managers, directors, market researchers and designers; as members of relevant congressional committees and executive branch agencies that control research and development funding, marketing subsidies, military procurement, and the like; as managers of government IT projects; as members of the judiciary that frequently hear high tech law cases; as academic researchers and publishers on technology issues (not only in computer science and engineering, but in law, medicine and other disciplines); as program officers, presidents and trustees of foundations and nonprofit organizations involved in technology policy and research; as organizers of technology-related ballot initiatives; and so on.

From the civic standpoint, girls need to know how computers work, both their capabilities and limits, primarily to develop personal and public codes of technology ethics, law, and policy. Girls need confidence in their own ability to effect change in computerized settings, democratize technology design, reflect on their own choices about computers and get feedback on their social impacts. They need to develop critical thinking and ethical reasoning skills both *with* computers and *about* them. A single piece of educational software might allow them to do both, for example, by simulating the impact of different methods of computer donation, recycling or disposal on a town's schools, environment and economy. A game might be built around the challenges of keeping and communicating secrets in a school where web and email monitoring software is deployed, spurring exploration of how such programs work and their legal and ethical dimensions.

Gender-Specific Features	Gender-Neutral Features	"Code" Issues
• Exploring realistic social relationships • Role playing in familiar settings • Nurturing • Negotiation and conflict resolution • Creativity and art • Exploring worlds rather than conquering them • Complex characters • Rehearsing teen and adult issues	• Customizability (ability to create own characters, narratives, objects, pace) • Strategy and skill development • Multiple levels, areas, narratives • Ability to use collaboratively, socially • Puzzles and mysteries • Focus on a goal	• Privacy (especially of children online) • Access, digital divide • Security • Virtual communities (and their relationship to physical ones) • Educational technology investment and uses • Commercial pressures on the Internet • Open and closed source software; monopolistic practices • Environmental impacts of computing

Figure 2: Some Engaging Design Features for Girls and Contemporary Issues of "Code"

Media designers concerned with boosting female participation in writing the larger code of the information age would be well-served by design principles common to constructivist (Papert 1993) and feminist pedagogy (Cassell 1998). Designers would foster users' active construction of games and web sites rather than laying down fixed rules and rigid structures. Designers could develop content from the start in consultation with girls about meaningful problems of interest to them, showing girls how computing is relevant to the sources, solutions and arenas for exploring these problems. Media could encourage users' autonomous experimentation and discovery with the computer itself rather than leading them down narrow paths toward predetermined conclusions or lessons. Design might foster greater cooperation and interactivity among users. This kind of approach aims to inspire ongoing, reflexive consideration of girls' own experience with computer

technology, "incorporating and coordinating considerations of self, others, and society" (Kahn, Jr. & Friedman 1998, p. 165). It asks girls to write not only programming code, but regulatory code.

Fig. 2 presents some design features that research has found are specifically compelling for girls (Beato 1997; Kafai 1996), and for girls and boys (American Association of University Women 2000), as well as some of today's most widely debated issues of code in technology law, policy and ethics. To serve girls' needs and rights as citizens, we can start drawing more lines between the columns, employing design features that work for girls to encourage them to explore questions of code and discover how they might shape the politics and architecture of computing.

Conclusion

This review of the literature suggests three distinct rationales for closing the gender gap in computing, indeed three different gaps: economic, cultural and political. It argues that scholars and policymakers have neglected the political gap and urges software and web designers to devote greater attention to addressing it. There are a number of good reasons for doing so. First, the cultural divide in computing already appears to be narrowing, as women go online in equal numbers and use the internet for communication. Second, by pursuing the approach suggested here, designers would more overtly foster girls' understanding of computing architecture, contributing to closing the economic gap as well by helping to familiarize girls with how the technology works as well as the social choices encoded in the hardware and software we use. Finally, and perhaps most important, this kind of design strategy would develop the kind of skills that all girls, and boys, need for effective citizenship in the information age: critical thinking with and about computing's impacts on our lives, and an appreciation of the relevance of information technology ethics and policy to gender-traditional and nontraditional interests.

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