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Bridging the gender gap in computing: An integrative approach to content design for girls

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Bridging the Gender Gap in Computing: An Integrative Approach to Content Design for Girls

Abstract

Although some observed differences in males' and females' attitudes toward and uses of computers appear to be narrowing, the gender gap remains widest in relation to programming and software design, which are still male preserves. In response, software and web site designers have applied feminist theories to develop three distinct approaches to creating content for girls that might increase their interest in computers. These approaches involve appealing to girls' traditional "feminine" interests, nontraditional "masculine" interests, and gender-neutral interests. This study proposes that to bridge today's gender gap, prior approaches need to integrate appeals to girls' traditional and nontraditional interests, and focus content more clearly on learning about computer design itself. An experimental test of this integrative strategy, used to develop a prototype World Wide Web site tested on girls in their homes (n=125), obtained significant increases in the treatment group's interest in, sense of relevancy of, and motivation to use computers, compared to a control group.

At a time when access to higher education, employment, and other life chances increasingly depends upon one's computer skills, research continues to reveal a gender gap in computing. Compared with boys, girls report less experience with computers (Goldstein, 1994; Sakamoto, 1994; Schumacher & Morahan-Martin, 2001), less confidence in their computing abilities (Young, 2000), and less interest in computers (American Association of University Women, 1999; Schofield, 1995). These factors likely contribute to the dramatic and persistent gender imbalances in employment in technical fields, where women comprise an estimated 20 percent of the information technology work force, and continue to be underrepresented in systems analysis, software design, programming, and technological entrepreneurship (American Association of University Women, 2000). The present generation of college and graduate students shows little sign of changing this imbalance. Women earned just 17 percent of the doctorates in computer science in 1998 (U.S. Bureau of the Census, 2000) and women's share of bachelor's degrees in the field declined from a historic high of 37 percent in 1983 to 28 percent in 1996 (Camp, Miller & Davies, 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).

However, the gender gap is shifting in important ways that highlight males' and females' different uses of computers. 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 women users (Hamilton, 2000). Yet, 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 tinkering, play, programming or systems design (American Association of University Women, 2000; Cassell & Jenkins, 1998; Schofield, 1995). This suggests that the gender gap should now be conceptualized not simply according to the amount of computer usage by males and females, but by how they use the technology, as females still appear to be less confident in exploring programming and systems design on their own terms.

This study explores one means of closing the gender gap: designing content (such as games, educational software and web sites) aimed at increasing girls' understanding of the relevance of computers to many aspects of their lives, as well as their self-confidence and interest in using computers, especially as programmers and designers. We review and critique prior design strategies' assumptions about both computers and girls' gendered interests, then propose and test a distinct approach that could be more successful at helping girls take control of computers for their own ends.

Significance of Content

Although many reasons have been offered for the gender gap, including educational practices, family dynamics, media stereotypes of male "computer nerds" and the workplace culture of the technology industry, the lack of suitable content for girls is often cited as a cause (American Association of University Women, 2000; Cottrell, 1992; Frenkel, 1990; Furger, 1998; Schofield, 1995). Early experiences with computers are likely to be important in shaping girls' orientation toward them and their willingness to explore the technology fully. Playing with computer, console and arcade games and educational software can provide an introduction to computer literacy, creating familiarity and building confidence in skills (Cassell & Jenkins, 1998). Games can develop children's cognitive abilities, including sustained attention and spatial orientation (Subrahmanyam & Greenfield, 1994). Boys enter school more familiar than girls with computers in large part because boys play computer games more (Kaiser Family Foundation, 1999; Williams, Ogletree, Woodburn & Raffeld, 1993). Most games fail to attract girls because they are designed primarily for the male market, employing combat and sports themes, often lacking female characters, or limiting females to the roles of passive victims to be rescued or huge-breasted vixens with guns (Gailey, 1993; Provenzo, 1991). Many girls are repelled by the violent plotlines in these games (Greenfield, 1994). Educational software often contains similarly stereotyped gender roles (Birahimah, 1993; Hodes, 1996) and violence that has been shown to induce greater stress in girl users than boy users (Cooper, Hall, & Huff, 1990). Despite the recent growth of games designed for girls, girls still buy only 12 percent of multimedia games (Gorriz & Medina, 2000).

The rise of the Internet has provided another, perhaps more hopeful, gateway to computing for girls. The interactive properties of the Internet, especially email and instant messaging, facilitate girls' interests in communication, information and collaboration (Blair & Tokayoshi, 1999). The World Wide Web can allow for greater personalization of content and characters than other digital media because content can be updated more frequently, and user profiles and search engines can be used to tailor it, which may account for why girls aged 2-12 use the medium as much as boys in their age group (Gorriz & Medina, 2000). Hypertext links may be more amenable to some girls' preferences for associational, nonlinear thinking that shows connections between information and people (Gerrard, 1999; Wakeford, 2000).

Nonetheless, these uses of the Internet do not address the ongoing gap between girls and boys in programming and design.

Significance of the Gender Gap

Are girls resisting more intimate knowledge of computing for their own legitimate reasons? Is difference necessarily a problem? Although some research (Schofield, 1995; Turkle, 1988) has found that gender stereotypes lead girls to feel that they must often choose between being computer-savvy and feminine, a recent survey of middle and high school girls finds them rejecting the notion that computers are an inherently male domain (Young, 2000). In focus groups, some girls suggest that they are not fearful of computers but disenchanted with a computer culture that is designed for boys' interests (American Association of University Women, 2000). These girls believe themselves to be morally or socially superior to boys, who girls portray as obsessively using computers, surfing the Internet for improper purposes, gaining a false sense of control over the world through computer games, and pursuing computer science for materialistic reasons. A survey of college-bound high school seniors in the technology-rich regions of Silicon Valley, Boston and Austin, Texas reported that girls were concerned that pursuing computer science would restrict their intellectual interests and relegate them to work that is dull, sedentary and anti-social (Garnett Foundation, 1997).

However, girls' perceptions of computing may be based on insufficient knowledge of the range of careers in the field and the growing relevance of computing to many disciplines besides computer science, as well as resignation to a culture of computing that is not welcoming to women (American Association of University Women, 2000). If this is the case, then girls' decisions to avoid computing may not be fully authentic and autonomous, but molded by gender bias and a lack of information. This possibility is supported by classroom studies that suggest gender differences in play, use and interest in computers decline after extended exposure to the technology (Greenfield & Cocking, 1994; Harel, 1991; Kafai, 1995; Linn, 1985). Gender differences likely depend upon context (Kafai, 1998). When girls are exposed to computers in single-sex settings with supportive teaching and appropriate software, they show increased interest and confidence in the technology (Craig, 1999; Crombie & Armstrong, 1999), develop skills (Lichtman, 1998), and show little difference in their attitudes toward and achievement with computers (American Association of University Women, 1998).

If the gender gap is not a product of free and fully informed choices, it raises significant concerns about equity and democracy. These concerns include women's equal access to educational and economic opportunity, and to explore technology and one's own identity through software and the Internet. In addition, as technology law and policy issues loom larger in the public sphere, understanding how computers and systems work is necessary for taking part in debates over technology design and regulation. Full citizenship requires some familiarity with code, or the architecture and law of cyberspace (Lessig, 1999), which shapes our experience there in profound ways, setting limits of privacy, security, freedom of association and information, and so on. For these reasons, numerous international governmental bodies have called for incorporating women's participation and knowledge into the design of information and communication technologies (see Gittler, 1999). These goals will not be met by technology designs and policy prescriptions for the information age that fail to address gender differences in views and uses of computers (e.g., U.S. Department of Education, 2000).

The shifts in the terms of the gender gap and its ongoing significance suggest a need to reconceptualize the gap and responses to it, along two lines. First, rather than assuming that girls are the problem and that the solution is to inculcate in them male norms about computers, researchers increasingly proceed from the standpoint that it is the culture of computing that is lacking and needs to change to open itself more fully to girls and women (e.g., American Association of University Women, 2000). The question, then, is not simply how females might become more interested in computers, but how females might encounter computing free of gender stereotypes. This approach aims to show girls that "they are free to explore computers in their own way and to draw their own conclusions about the usefulness of these machines" (Coyle, 1996, p. 54). Second, the growing economic and political importance of understanding the workings of technology, and the persistent lack of appeal of design and programming to girls, suggests that efforts should be focused on addressing females' lesser confidence and interest in these aspects of computing, so that women can take their places "not simply as consumers and end users of technology, but as designers, leaders, and shapers of the computer culture" (American Association of University Women, 2000, p. 4).

Design Strategies for Girls

Software and web site designers have recently turned their attention to remedying the lack of appealing content for girls, sparking a lively debate over appropriate design strategies (Cassell & Jenkins, 1998; Gorriz & Medina, 2000). The controversy reflects larger differences within feminist theory over the norms embodied in traditional and nontraditional gender roles, and the construction of identity. We distinguish these sometimes overlapping strategies here for analytical purposes, showing how each implies its own predictors for increasing girls' sense of the relevancy of computers to their lives, and building their use of, and interest in, the technology.

In the mid-1990s, female software designers developed what they called a “girl games” strategy, giving birth to a range of software and web sites that appealed to girls’ traditional gender interests in collaboration, relationships, negotiation, glamour and creative design (Glos & Goldin, 1998; Subrahmanyam & Greenfield, 1998). Structurally, girl games eschew the timed, linear progression through levels of mastery typical of boy-oriented games, instead offering a web of multiple paths through stories or environments. This strategy suggests that the most effective way to increase girls’ use of and interest in computers is to demonstrate their relevance to exploring traditionally gendered subjects in a setting that validates established norms for women. In this, it fits well with cultural feminism’s assertion and celebration of a distinct women’s culture characterized by its own interests in nurturing and self-fashioning and its own ways of knowing (e.g., Belenky, Clinchy, Goldberger & Tarule, 1986; Gilligan, 1982). This strategy’s assumption that girls’ play preferences with computers differs from boys’ is well supported by prior research and the commercial success of some game girl software, most notably *Barbie Fashion Designer*, which built on the iconic doll’s brand name to become one of the most popular CD-ROM games shortly after it was introduced in 1996 (Gorriz & Medina, 2000). The approach extends to web sites for girls that primarily feature information on dating, friendships, shopping and communication.

Critics of the girl games strategy object that it upholds stifling gender roles (Cassell & Jenkins, 1998). By relying on market research to identify the majority of girls’ preferences, this approach may simply tailor itself to the confining tastes in which many girls have been socialized previously, rather than reflecting authentic choices or permitting all girls to explore the full range of their identities. By reinforcing learned preferences, this strategy may naturalize both a single “feminine” identity and orientation toward computers as merely tools for exploring existing interests rather than developing new ones. Critics' charges find some empirical support in research on boys (Kafai, 1998) and girls (American Association of University Women, 2000) that suggests that when children are asked to design their own games they show a broader range of play preferences than is catered to by the gender-specific software industry.

A second strategy, developed primarily by teenage and young women game players, embraces existing aggressive software designed for boys and demands comparable female action figures, hoping to empower girls by spurring their competitiveness and assertiveness. These self-described "game grrls" aim at appropriating into their own subculture the traditional male domain of computer games, particularly its images of feminine warriors and potent female sexuality (Jenkins, 1998a; Wakeford, 2000). On web sites devoted to discussing and playing computer games, game grrls reject what they perceive to be overly sanitized images of femininity in girl games, as well as images of women as passive victims, which game grrls accuse both boy games and prior feminist thinking of perpetuating. From this standpoint, the optimal way to boost girls' interest and use of 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.

However, motivating most girls to play competitive and violent computer games may not only be sisyphean but disparaging of traditional feminine identity. Widespread devaluing of preteen girls' interests and abilities contributes to their dramatic loss of self-esteem and confidence as they enter the middle school years (Pipher, 1994; Seiter, 1993). Rather than slighting girls' facilities for collaboration or nurturing, there is a social good in fostering them rather than violence as a means to power for both boys and girls. That mainstream computer content often fails to do so is little cause for celebration. If some, generally older, girls are capable of rewriting this material into their own liberating narratives of self, this does not change the reality that its "constructions of female sexuality and power are designed to gratify pre-adolescent males, not to empower girls" (Jenkins, 1998b, p. 291).

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 its 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. This strategy's exploration of unisex interests derives as well from postmodern feminists' insights into the constructed, performative and context-dependent nature of gender differences (e.g., Butler, 1990).

Gender-neutral design holds promise for overcoming both girls' reticence about exploring the computer and boys' predilections for violent games containing sexist imagery. However, pursuing this logic exclusively could also constitute a flight from, or silence about, addressing gender itself, and would not guarantee that girls will use technology in ways that help them challenge existing stereotypes about themselves and technology. The neutered characters of some software, which have been criticized by some teachers as unrealistic and condescending to children (American Association of University Women, 2000), may represent a kind of "one-size fits all" mentality that fails to recognize and confront lived gender differences. Despite Cassell's interest in her games fostering children's process of constructing their identity, including gender identity, there is little in her games that specifically raises issues of gender. By simply eliciting stories, this software may only bring forth the stories girls have been socialized to tell about themselves. Furthermore, it is not entirely clear that using computers for sharing stories about oneself is entirely a gender-neutral activity. One could argue that self-narrative is closer to traditional feminine uses of computers for communication. This indicates a larger challenge for advocates of this approach: it is difficult to identify and operationalize truly gender-neutral subjects and ways of structuring computer content, given the debates over the gendered nature of many topics, ways of knowing and communicating that are revealed in the controversy over design for girls itself.

Finally, none of the three strategies inspires sufficient confidence in the relationship between childhood play and future computer use. If designers hope that their software and web sites will spark girls' interest in computers *per se* – rather than simply in fashion, combat, or story-telling – there is little in these approaches that focuses on teaching children about how computers work and how children might design them for their own ends. With rare exceptions, such as Cascade Pass's "You Can Be a Woman Engineer" CD-ROM and the sections of some web sites devoted to coding and technical careers, content for girls continues to present the computer as a vehicle for other interests, rather than an object of interest in its own right. As computers become easier to hide in toys and other objects, playing with them may paradoxically become less relevant to building technical skills and confidence with something that is recognizably a computer. If the gender gap is now more about programming and design, then content for girls may need to focus more on demonstrating the relevance and interest of these activities if it hopes to further progress toward equity.

Might some of the shortcomings of these approaches be overcome by a new strategy that integrated appeals to traditional and nontraditional interests to increase girls' involvement in programming and design? Such an approach could offer several advantages. From a normative standpoint, an integrative strategy would be more inclusive and welcoming of the full spectrum of girls' interests, rather than prescribing a more narrow set of ways to be both feminine and computer literate. From a pragmatic standpoint, this strategy might also engage more girls in using the technology than existing efforts by showing the relevance of computers to a broader range of activities, while avoiding some of the conceptual difficulties of defining "gender-neutral" topics. By placing greater emphasis on how computers work, this strategy could also increase the likelihood of integrating computer usage for applications and communication with exploring how the technology is designed and programmed. This approach could serve girls well at a time when computer systems have become indispensable to a wide range of fields, such as medicine, law and the arts, which suggests that there will increasingly be multiple points of entry into computer design, not simply computer science (American Association of University Women, 2000). However, according to existing design theories, there are reasons why an integrative approach could fail. The presence of content aimed at nontraditional gender interests might dissuade girls, while content that appealed to traditional gender interests might alienate grrls. Directing greater attention to programming could strengthen many girls' attitudes toward computers as tiresome and anti-social.

A prototype World Wide Web site (http://itrs.scu.edu/egurls/) was designed for this study to test the effectiveness of an integrative strategy. We hypothesized that by demonstrating connections between computers and girls' traditional and nontraditional interests the integrative approach would increase girls' motivation to use computers in the future (H1), increase girls' interest in computers in general (H2), increase girls' interest in computer programming and design (H3), increase girls' interest in other uses and applications (H4), and increase girls' ratings of the relevance of computers to their lives (H5).

Method

Stimulus and Control Group Materials

The web site to which the experimental group was exposed was designed for elementary and middle school girls, ages nine to twelve years, because girls' participation, confidence and interest in computer, math and science classes begins to diminish at this time (Furger, 1998; de Castell & Bryson, 1998). During the middle school years girls become more attentive to the expectations of gender roles, which take on larger importance in their identity formation (Glos & Goldin, 1998). Thus, reaching this age group is especially important for engaging girls in computing. The gaming industry recognizes girls aged nine to twelve as a distinct market segment with its own needs and interests (Gorriz & Medina, 2000).

The site was structured to appeal to a broad range of traditional and nontraditional interests and to show how computers were relevant to each of them. The home page was divided into three categories – Interests, Projects and Careers – each of which offered a link to a gender-traditional topic and nontraditional topic (see figure 1). Traditional topics were drawn from the subjects and activities frequently found in girl games, including fashion, drawing and storytelling, and art. Nontraditional topics were drawn from science (bugs and slugs) and uses of computers in which males predominate (coding, microprocessor design). Both traditional and nontraditional topics acted as vehicles to learning more about computers, as each link from the home page led to pages about how women in various fields used computer applications and programming skills to design, depict or study these topics. For example, following the link to fashion brought the user to pages that described how computers were used to design fabrics and mix chemicals in make-up, then to a profile of fashion designer Vera Wang. Following the link to nontraditional careers led to pages profiling women designers of microprocessors and software, and a woman systems analyst. Choosing gender-traditional careers in computing presented the greatest challenge, given the under-representation of women in many technical fields. Here, pages focused on women using computers to create art or teach, and a story about a woman who conquered her fear of damaging the computer, a common concern among girls (Furger, 1998), and eventually became a network administrator. The total number of pages devoted to traditional and nontraditional topics was equal, at nine apiece. The site was self-contained, offering no links to other sites on the web.

—Insert Figure 1 here—

The site design was informed by several other findings from the research on girls' learning and play preferences with computers. Because girls prefer computer science classes that demonstrate how the technology can be useful for concrete tasks in real-life situations (Brunner, 1997), the site emphasized the end-results of programming and design, such as using html code to make a personal web page or designing software to study the health of a rain forest. Because programs that involve female role models and mentors in the professions have succeeded in encouraging girls to explore nontraditional careers (American Association of University Women, 1999), and girls show interest in rehearsing the work lives of women (Brunner, Bennett, & Honey, 1998), the site included professional and personal profiles of women in systems analysis, software design, and so forth.

The site was designed to be used by girls at home, for several reasons. First, the site aimed to bridge the gap in computer use at home, where girls spend less time using computers than boys do (Schofield, 1995). Home use is important to building proficiency with computers (Martinez, 1994) and contributes to academic achievement with the technology (Rocheleau, 1995). Second, the study attempted to bypass the gender dynamics of many school computer labs, where machines are typically dominated by boys in a competitive atmosphere (Furger, 1998). Third, conducting the study in the home was also an attempt to mitigate the influence of growing pressure in the study area, a center of the high technology industry, to use computers in schools and view them positively. By testing the girls in their homes, we hoped to reduce the likelihood of their rating the site more favorably in order to give socially desirable answers, and to minimize communication about the study between subjects that might have contaminated the results. Fourth, although lab studies offer greater control over the influence of extraneous variables, field experiments such as this can make stronger claims to ecological validity because they are conducted in a less artificial setting (Christensen, 1994).

The control group viewed 8 ” x 11” flash cards containing material comparable to the topics on the web site, minus all references to computers and their relevance to these topics. Flash card topics encompassed a mix of gender-traditional and nontraditional topics, including fashion and make up, bugs and insects, teaching pre-school, drawing comic strips, making up codes, and fighting fires. The flash cards employed text and color graphics similar to those used on the web site and were presented to participants face down, with their topics visible to the girls, to approximate the interactive experience of navigating through the web site.

Subjects

Girls aged nine through twelve were recruited by distributing flyers and parental consent forms in English, Spanish and Vietnamese seeking participation in a study of “how to help girls learn better, using different technologies.” Flyers were distributed in 18 public schools in seven school districts in Northern California. The schools were chosen to maximize the diversity of economic and racial backgrounds of the subjects in a primarily high-income area. A $20 incentive fee was offered to each participant.

A total of 125 girls participated, 66 in the experimental group and 59 in the control group. Nine-year-olds comprised 24 percent of participants, ten year olds 37 percent, eleven year olds 31 percent, and twelve year olds 8 percent. The group was racially and ethnically diverse, with 34 percent of girls identifying themselves as White, 33 percent as Latina, 23 percent as Asian-American, 9 percent as African-American, and 1 percent as Other. The girls’ economic background reflected the area’s affluence, with 26 percent of parents reporting annual household incomes under the approximate national median of $35,000, 24 percent reporting incomes of $35,000 to $74,999, and 50 percent reporting incomes of $75,000 or above. Most girls had access to a home computer, with 90 percent saying that someone in their family had a computer in the home and 35 percent saying they owned their own home computer.

Procedure

Girls who returned parental consent slips by mail were randomly assigned to the experimental or control group, then contacted by the researchers to arrange for a home visit when a parent or guardian was present. All girls were tested by one of three female researchers, allowing the team to control for effects of researchers' gender on participants, and likely increasing access to participants' homes and the ability to test each girl alone. After arriving at the home, the researcher asked to show the girl educational materials in a quiet room in the house. In almost all cases, the test took place in the girl's own room. The researcher administered a pre-test survey orally while also providing a copy of the questions for the subject to view to overcome any lack of familiarity with responding to surveys. The pre-test measured girls' existing attitudes towards, and use of, computers and the other topics mentioned in the web site and control group materials. Researchers explained that they were interested in participants' own honest responses, that there were no right or wrong answers to the questions, and that the girl could stop at any time.

Girls were then asked to spend twenty minutes reviewing the materials. Experimental subjects explored the web site on a laptop provided by the researcher. The researcher briefly instructed the girls how to use the laptop and explained the layout of the home page, including how to click on the links, telling the participant that she could follow links to any topics she chose off the home page and could return to the home page at any time to pick another topic. Doing so ensured that every girl began the experiment with enough information to view the site, regardless of her prior computer experience.[2] Control subjects viewed the flash cards. The amount of time allotted allowed almost all experimental participants to view the entire web site, and almost all control group participants to read every flash card. The researcher remained silently in the room during the experiment. The post-test, administered similarly to the pre-test, asked the same questions as the pre-test plus demographic information such as race and age. Researchers then gave a self-administered questionnaire to the parent or guardian present to gather demographic information about family income. Home visits averaged 45 minutes long.

Measures

Motivation to use computers, interest in computers, and the perceived relevance of computers were the three key areas assessed by the 20 item pre-test and 27 item post-test questionnaires.

Motivation to use computers in the future was measured by a single question that asked the participants how much they would like to use computers in the future, with response categories ranging along a 5-point scale from "more than you do now" to "less than you do now."

General interest in computers was measured by a single question asking girls how much they wanted to learn about computers in the future (on a 5-point response scale ranging from "a lot" to "not at all"). Interest was also gauged through a series of questions asking girls how much they wanted to learn about specific computer uses and applications in the future, with each item measured on a 5-point response scale ranging from "a lot" to "not at all." Items relating to

[2] It may be objected that providing participants with a laptop could have created a halo effect, or positive impression of the researcher that then extended to participants' evaluation of the web site. However, the study population already enjoyed very high rates of home computer access, and demonstrated familiarity with using a laptop and

computer programming or design were grouped together, as were items related to other applications or uses of computers. The “interest in programming or design” measure consisted of 3 items: HTML code, designing software and designing computers. Cronbach’s alpha for this index was .52 for the pre-test data and .59 for post-test data. The “interest in other applications” measure included 4 items: computer art, teaching over the Internet, computer animation, and teaching companies to use software (Cronbach’s alpha for pre-test data was .70; .70 for post-test data).

The relevance of computers to different areas of the participants’ lives was assessed through questions asking how *useful* computers will be in their future for “fun” and for a “job.” A parallel question asked respondents to indicate how much they thought computers *will be part of* their future for “fun” and for a “job.” Each question was measured along a 5-point response scale. The two recreation-related responses were combined, as were the two work-related responses to create separate relevance measures. Cronbach’s alpha for the pre-test recreation measure was .68; the post-test recreation measure was .83. Cronbach’s alpha for the pre-test work-related measure was .79; the post-test work-related measure was .86.

Analysis

The principal analyses compared the post-test scores of the treatment group with the control group on the key dependent variables using a multivariate analysis of covariance, with the pre-test scores as covariates. This procedure follows the approach outlined by Schafer (1992). Secondary analyses were subsequently conducted to test for within subject differences according to race or ethnicity, age, and family income level.

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navigating a web site when asked to do so, suggesting that neither the laptop nor the World Wide Web were new to them or of special, intrinsic interest.

Results

The multivariate analysis of covariance yielded significant results ($F(6, 125) = 13.20$, $p < .001$). Further examination of the between-subjects effects demonstrated significance for five of the six dependent variables tested. Table 1 provides the relevant means and standard deviations for the treatment and control conditions for each of the six post-test measures.

-- Insert Table 1 here --

We hypothesized that the girls in the treatment condition, who experienced the integrated approach to information about computers delivered via the web site, would be more motivated to use computers in the future, compared to girls in the control group condition, who received non-computer related information via the flash cards (H1). This was supported by the data ($F(1, 125) = 15.33$, $p < .001$).

Similarly, we predicted greater interest in computers—both at a general and specific level—by girls in the treatment condition compared to girls in the control condition. The three measures of interest—general interest (H2), interest in programming and design (H3), and interest in other uses and applications (H4)—all showed higher levels among the girls in the treatment condition, supporting our hypotheses ($F(1, 125) = 4.77$, $p < .05$; $F(1, 125) = 61.73$, $p < .001$; $F(1, 125) = 14.78$, $p < .001$, respectively).

The hypothesis that exposure to the web site would lead to greater perceived relevance of computers to one's life (H5) among the girls in the treatment group when compared to the control group received mixed support. Girls in the treatment group perceived the computer as more relevant to "fun" than girls in the control group ($F(1, 125) = 4.74$, $p < .05$), but there were no differences between the two groups in their assessment that computers would be useful and significant for their future job ($F(1, 125) = .26$, $p = .62$). An examination of the post-test response levels on this measure shows near unanimity among participants—they all believe computers will be very important for work, regardless of which condition they were assigned (treatment group M = 8.98; control group M = 9.14, out of a possible score of 10). Examining the pre-test responses reveals a ceiling effect, as both groups initially rated computers highly useful and important for their future work (treatment group M = 8.61; control group M = 8.90, out of a possible score of 10), leaving little room to raise their scores significantly on the post-test.

Although not part of the hypothesized effects, analyses were conducted to test whether participants varied in their post-test scores according to race or ethnicity, age, or family income level. A multivariate analysis of covariance incorporating these variables, along with treatment or control group membership, revealed no significant main effects for race or ethnicity, age, and income level or significant interaction effects for any of these variables.

Discussion

The results of this experiment suggest that integrating appeals to traditional and nontraditional "feminine" interests, and demonstrating how computers are linked to both, can influence girls to have a more positive orientation toward computers than they do now. This integrative design strategy employed on a web site increased girls' motivation to use computers. The strategy also boosted girls' interest not only in computers in general but also in programming and design, where the gender gap remains widest, as well as in other applications. In addition, the approach increased girls' sense of the relevance of computers to recreation, despite prior studies' findings that many girls view computers as dull and unsociable (Garnett

Foundation, 1997). Although the study design could only demonstrate short-term effects on participants' attitudes, it suggests an integrative approach is worth applying and testing further.

The strategy's generalizability was strengthened by participants' racial and ethnic diversity and the absence of effects of age, race and household income on the girls' reaction to the web site. However, the fact that participants came from households with high rates of computer ownership and from a region where the economy is based largely on technology development may limit generalizability. The study's inability to find significant impacts on girls' sense of relevance of computers to their work is likely traceable to the participants' already high estimation of the usefulness of computers for this purpose, which is not surprising given their residence in a region where technology careers are ubiquitous, lucrative and celebrated. Girls with less access to technology in the home, or who live in an area where computers are more likely to be seen as irrelevant or even as a threat to employment, may be less willing to change their attitudes about technology positively.

It may be objected that the treatment group's larger increase in positive attitudes toward computer-related topics was an effect of having been exposed to information through a web site, a richer medium that engaged more of the senses than the control group flash cards. If so, we would expect that the experimental group would also have demonstrated a greater increase in positive attitudes toward non-computer related topics that were covered in both the web site and the flash cards. To test for this possibility, we conducted a multivariate analysis of covariance to measure interest in four non-computer topics common to the flash cards and web site: fashion, make-up, bugs and insects, and creating stories and pictures. Using the pre-test interest scores as covariates, we found no significant differences between the experimental and control group in their post-test interest in these topics ($F(4,116) = .879$, $p=.48$).

Future research might test comparatively the effectiveness of the four approaches to software design discussed here – traditional, nontraditional, gender-neutral and integrative – for increasing girls' involvement with computers and teaching specific computer skills. It could elaborate more sensitive, multi-item attitude measures than were used here. However, it is equally important to take stock of the breadth of identities offered by each design approach. We would argue that a strategy that recognizes and validates the full range of girls' interests, whether they fit traditional expectations or not, is more socially desirable than a strategy that offers a limited vision of what it means to be feminine, no matter how effective that strategy may be for other purposes.

Although this study showed only short-term effects on girls' attitudes toward computers, if technical literacy is indeed "a process that is developed . . . in stages involving experimentation" (American Association of University Women, 2000, p. 10), then repeated exposure to web sites, games and educational software employing an integrative strategy might reinforce the effects obtained here and help close the remaining gender gap. Assessing this possibility implies a different research program than has been pursued to date. Rather than presenting children with games or web sites and measuring their acceptance or rejection of them, or asking children to design their own content, researchers concerned with design could turn to longitudinal studies that measure the impacts on girls' educational and career choices of the computer content and experiences to which girls are exposed repeatedly. Does using "pink software" designed for girls' traditional tastes really influence girls to take computer classes and become systems analysts, as girl games advocates seem to promise? Does playing violent "boy games" really empower girls to design their own software and hardware? Does gender-neutral content further these goals? Would software and web sites that show the relevance of computer programming and design issues to girls' varied interests and to their everyday lives have a better chance of achieving these ends? How influential is computer content at all in our choices of courses and careers, compared with the messages in the broader popular culture, peers, parents, teachers and professional mentors, educational practices, and the workplace culture of high technology?

Perhaps the clearest implication of this study is that content designers who want to interest girls in computing have good reason to regard the choice between designing to girls' traditional or nontraditional tastes as a false dilemma. Integrating the full range of girls' preferences did not appear to be a barrier to increasing interest in computing, even in the most male-identified uses of computers, such as programming and design. Nor need designers necessarily take a gender-neutral approach. Content that addresses girls as girls, yet recognizes the broad spectrum of their interests, does appear to be able to whet their appetites for computers.

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Figure 1. Site Map of Pages and Links on Experimental Web Site

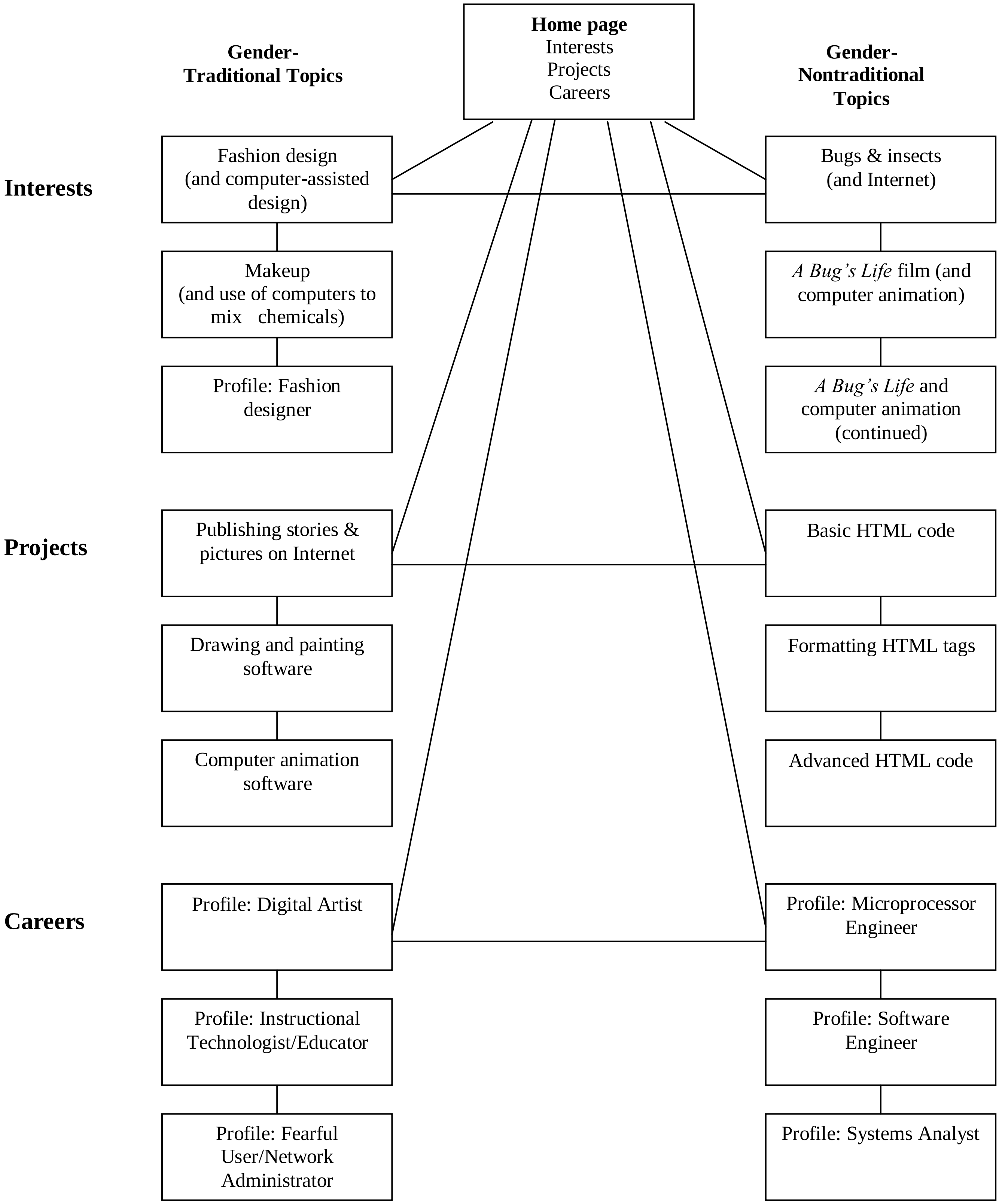

Table 1. Mean Post-Test Scores for Dependent Measures for Treatment and Control Groups

Dependent Measure	Treatment Group (N=66) M	Treatment Group (N=66) SD	Control Group (N=59) M	Control Group (N=59) SD
Motivation to use computers in the future[a]	4.50	.59	4.24	.77
General interest in computers[a]	4.33	.88	4.25	.84
Interest in programming & design[b]	10.36	3.08	8.02	2.85
Interest in other uses & applications[c]	14.88	3.30	13.86	3.77
Perceived relevance—computers will be part of fun[d]	7.89	1.71	7.24	2.05
Perceived relevance—computers will be part of job[d]	8.98	1.72	9.14	1.06

Note. The higher the score is, the greater the attribution.

[a]Maximum score is 5
[b]Maximum score is 15
[c]Maximum score is 20
[d]Maximum score is 10