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Gender differences in factors influencing students towards computing

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This paper examines students' pre-college experience with computers. It finds significant gender differences in how students develop interest in computers; exposure to computers at home; availability of computers in high schools; and high-school preparations for college study in a computing field. The paper has a number of implications to improve the digital divide for women. It is based on 150 in-depth interviews of female and male undergraduate students, members of five major ethnic/racial groups (White, Afro-American, Hispanic, Asian American, and Native American) from seven institutions in the USA.

Keywords: attrition; digital divide; gender gap; minority-serving institutions; retention

Introduction

The popularity of computer science (CS) as a major among incoming undergraduates at US institutions grew sharply in the early 1980s, maxed out in the mid-1980s, plunged abruptly before leveling off in the early 1990s, increased again hitting the highest point in the late 1990s, and has been dropping since then. The percentage of incoming undergraduates indicating they would major in CS declined from 5.2% in 2000 to 1.6% in 2006 (a 70% decline). Of incoming undergraduates in 2006, 3.3% men and 0.4% women indicated CS as their probable major, down from 9.3% men and 1.9% women in 2000 (National Science Board, 2008). Overall, women's interest in CS has not grown at the same rate as men's. As a result, the disparity between men and women who thought of majoring in CS has increased. Incoming undergraduates' interest levels have been a reasonable forecast of trends in the number of bachelor's degrees awarded four to five years later. This suggests fewer bachelor's degrees would be granted in CS in the near future in general and for women in particular. This is despite the efforts of the government (e.g., Broadening Participation in Computing Program of the National Science Foundation) and women groups (e.g., National Center for Women in Information Technology) to encourage the participation of women in computer-related fields.

Scholars have been studying the relative paucity of women in CS education since the early 1990s (see, Ahuja, 2002; Cohoon & Aspray, 2006; Singh, Allen, Scheckler &

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Darlington, 2007). Greater use of computers at the pre-college level is repeatedly viewed as generating interests and providing training to students to pursue a college degree in a computer-related field (Adya & Kaiser, 2005). Most decisions to take up a career in science, technology, engineering, and mathematics (STEM) fields including CS are made rather earlier, long before reaching age 17 (American Association of University Women, 2000). Over the past 20 years, computers and other information technology resources have been diffused widely at home and in the US K–12 educational system. Still, computers are acquired to a greater extent by more affluent and well-educated Americans who tend to be White males (Cooper & Weaver, 2003). Lack of early access to computers and information technology resources has been seen as a deterrent for women (see, Rowell et al., 2003; Kahle & Schmidt, 2004).

Yet, there have been few empirical studies conducted on the gender divide on students' pre-college experience with computers, which include students from different ethnic/racial groups and from minority-serving institutions. This paper analyzes differences between female and male students from different ethnic/racial groups in CS and computer engineering (CS/CE) programs at minority-serving institutions with respect to their pre-college experience with computers. To reflect various stages of pre-college experience with computers, the paper tests the following four hypotheses:

(1) H_1: Female and male students will differ significantly in how they become interested in computers.
(2) H_2: Female and male students will differ significantly in exposure to computers at home while growing up.
(3) H_3: Female and male students will differ significantly in the accessibility of computers in high schools.
(4) H_4: Female and male students will differ significantly in their perception in degree to which high schools prepare them to study computing at the college level.

The state of knowledge

Historically, compared with men, women's interest to pursue a career in a computer-related field has been restricted. Many reasons have been proposed for such a gendered gap. The literature on students' early career interests in computer-related fields can be grouped into three areas: bias in socialization, structural barriers, and lack of proficiency in STEM fields.

Socialization theorists have argued that while boys are raised to be in a computing (or a STEM) field, girls are brought up to be in traditional fields such as arts, humanities, and social sciences. Gender stereotypes, family upbringing, media portrayal, and role models all have direct or indirect social influence on the career choices of children (Frenkel, 1990; Spertus, 1991). Family provides one of the most powerful environments for childhood and adolescence socialization. Children are likely to choose careers in computer-related fields if they are encouraged by their family members (Trauth, 2002). However, as children grow, they begin to make out which occupations are for "males" and which ones are for "females". Girls gradually learn to carry out their female roles, and boys progressively discover the importance of computing and STEM skills. The stereotype that computers are for males shapes the expectations of parents, family members, and students themselves (Varma, 2002). Both male and female children end up accepting as true that computers are for boys, who have intrinsic fascination with the powerful machinery (Margolis & Fisher, 2002). The general picture of computer-related fields is of a White male, geek/hacker/nerd, and super smart, who sits in front of the computer all day and sleeps near it. His socialization is limited to talking about computers all the time (Barker & Aspray, 2006). Media depicts women on their physical image rather than on career choices in STEM and computing (Thom, Thompson & Hoy, 2001). Fewer females in the field further reinforce the image that computer-related fields are not meant for females (National Academy of Sciences, 1997). The role models directly or indirectly influence career choices.

Structural theorists add institutional factors such as role of schools, access to computers and information technology resources. Studies show gender differences in specific uses of computers. For instance, one study found gender to be prominent in how people use the Internet (Kennedy, Wellman & Klement, 2003). Similarly, gender disparity was reported on perception of having computer expertise and use of computers for entertainment purposes (Creamer, Burger & Meszaros, 2004; McCoy & Heafner, 2004). Another study discovered men were more likely to have used computers for programming than women (Beyer, Rynes & Haller, 2004). Further, students attending high-poverty and high-minority schools have less access to computers and related resources (Cooper & Weaver, 2003). One study found female students taking fewer technology classes (Pinkard, 2005). Teachers and/or councilors tend not to be gender neutral in directing students towards computer-related careers (Adya & Kaiser, 2005). Young boys playing with video games end up feeling comfortable with computers later; computer games are designed with boys' interests in mind (Gorriz & Medina, 2000). Often children commence their first interaction with computers through the video game.

Finally, anxiety toward mathematics is seen as a critical filter that contributes toward gender differences in computer-related fields. This is despite the fact that the gap between female and male students' scores in mathematics began to narrow down beginning in the early 1990s; a recent study found that maths scores show no gap for girls (Hyde, Lindberg, Linn, Ellis & Williams, 2008). Still, many believe that boys are "naturally" better than girls at maths. For instance, Lawrence H. Summers, then the president of Harvard University, remarked at the National Bureau of Economic Research (NBER) conference on 14 January 2005, that innate differences between men and women may be one reason fewer women succeed in STEM careers. However, most research has shown that the gap in standard mathematics scores between boys and girls has little to do with biological differences. One study found a combination of social and structural factors results in incoming freshmen females underestimating their ability with computers more than males (Cooper & Weaver, 2003). Another study noted that despite the fact that female students have a solid background in mathematics and sciences and have taken some computer courses in high school, they feel less prepared than the male students in computing due to the geek mythology (Margolis & Fisher, 2002). A survey of over 550 students revealed that both men and women had similar scores on American College Test (ACT) mathematics, but men held more positive attitude towards their expertise than women (Beyer et al., 2004). Gendered self-confidence seems to affect women's confidence in computer-related fields.

Methodology and analysis

An empirical study was undertaken to understand the reasons for under-representation of women majoring in core information technology disciplines, namely CS/CE at institutions of higher education. In-depth interviews were conducted in 2004–2005 with undergraduate female and male students who were majoring in a CS/CE field. The field work was carried out in seven institutions that granted undergraduate degrees in one or more CS and/or CE programs and were designated as minority-serving institutions in the USA – a category of educational establishments such as Hispanic-serving institutions, historically black colleges and universities, and tribal colleges and universities. These institutions were included because they grant a high proportion of undergraduate degrees to minority students. The sample included 150 students, divided into groups of 30 (15 females and 15 males) belonging to one of the following five major ethnic/racial groups: White, Afro-American, Hispanic, Asian American, and Native American. Students from major ethnic/racial groups were included because often scholars have made claims about women in general even though their sample consisted of mostly White individuals. Data collection involved using interview guides, asking the same 61 open-ended questions, recording the answers, and following up with additional relevant questions or probes. Students interviewed were in their second and third years of CS/CE study. Random sampling was used to select students on sites with sufficient numbers of females and males; however, purposive sampling was used at sites lacking sufficient numbers of some groups (e.g., Native Americans) majoring in CS/CE.

Four out of 61 questions provided the specific data on students' pre-college experience with computers (Appendix 1). A content analysis coding scheme was developed to assess how students developed interest in computers, if their families owned a computer for students to use, whether computer resources were available to students in high schools, and how well high-school classes prepared students for the CS/CE study at the college level. Two independent trained coders coded the interviews to ensure consistency and objectivity.

The cross-tabulation function of SPSS version 14.0 was used for testing the significance of the differences in the perceptions of male and female students. Statistical testing for H_2–H_4 was based on Pearson Chi-square or χ^2 test; this test was not conducted on H_1 because students provided multiple responses. In addition, hypothesis testing was not done for ethnic/racial groups because of the small number of cases; 15 female and 15 male students in each ethnic/racial group are likely to show significant results only if the differences are very large. Findings are presented by using both quantitative data and interview excerpts.

Findings

Development of interest in the computer

Students' responses were coded into seven categories: early exposure, technology, family, rewards, applications, later exposure, and non-family. Since students gave more than one reason for their interest in the computer, their statements were coded into multiple categories. "Early exposure" reflects comments which conveyed an environment up to high school within which students identified becoming interested in computers. The category of "technology" included statements which showed that students had an instinctive interest to tinker with the machine for their fascination with computers. Remarks which contained father, mother, siblings, and relatives as being instrumental in initiating students' attention to computers were placed in the "family" category. The "rewards" category consisted of any terminology used for monetary gain, employment, fulfillment, and success to get students attracted to computers. The category of "applications" is comprised of expressions which showed functions such as graphics, games, Web messaging, and schoolwork to sustain students' appeal in computers. The "later exposure" category incorporated statements which suggested environment, after high school, within which students found themselves becoming interested in computers. Finally, the category of "non-family" included people namely teachers, councilors, and friends who drew students' awareness to computers.

The first hypothesis predicted that female and male students would differ significantly in how they become interested in computers. Since students gave multiple responses, the χ^2 test was not performed. Table 1 shows that the exposure to computers (133 responses) was the main reason for students to get interested in them. Table 1 also shows significant gender differences among students on early exposure to computers (63% male vs. 37% female) and later exposure to computers (35% male vs. 65% female). Gender differences on other sources of interest in computers such as instinctive interest with technology (66% male vs. 44% female), rewards associated with computers (41% male vs. 51% female), and non-family members' guidance (59% male vs. 41% female) were also large; only family members' encouragement (46% male vs. 54% female) and applications associated with computers (48% male vs. 52% female) had minor gender differences. This suggests that gender affects how students get interested in computers, thus supporting H_1.

Table 1 shows that the large majority of students (62%) became interested in computers from the early exposure. Table 1 also reveals that more male (63%) than female (37%) students had early exposure to computers. As this male student declared, "I had computers in my house since I was born, so I began using them before the majority of people might have". Another explained, "There was a computer in our home since I was really young. My parents bought a Commodore 64 way back in 1982, so I was in a position to mess with them". This male student remembered "playing video games, playing with computers at home since [he] was

Table 1. Development of interest in the computer.

	Total respondents (n = 150)		Respondents by gender			
			Female		Male	
Sources of interest	n	%	n	Conditional %	n	Conditional %
Early exposure	93	62	34	37	59	63
Technology	59	40	26	44	33	66
Family	59	39	29	54	30	46
Rewards	46	31	27	59	19	41
Applications	42	28	22	52	20	48
Later exposure	40	27	26	65	14	35
Non-family	17	11	7	41	10	59

Note: Respondents provided more than one response; thus, percentages do not add up to 100.

really young”. For those who did not have computers at home, schools were instrumental in providing early access. As this male student recalled, “I first touched a computer when I was in elementary school. I was in a gifted program and we got to do a little bit of this, little bit of that”. Another told a story how his county raised funds for elementary schools to buy computers, which got him “started and [he] just kind of went from there”. Female students, on the other hand, had somewhat different stories to tell. Their early exposure to computers tended to be when they were in high schools rather than in elementary or middle schools. As this female student said, “I took a computer class in high school and that is where my interest started”. Another believed, “The first time I ever used a computer was in my sophomore year in high school”. This female student did not get to use a computer until she “got into high school”. She was pulled towards them when she watched “a technician in [her] high school fix a computer”.

Most importantly, female students were exposed to computers later in their lives, namely in colleges or at work. As Table 1 demonstrates, among those who had later exposure to computers (27%), there were more female (65%) than male (35%) students. This female student took a “computer class at a community college where [she] found an interest in computers”. A female student told this story: “I started to work in an architectural program. We did hand drawing, technical drawing, and then the company bought PCs and we started to do AutoCad. This is when I became drawn to computers”. Another took an administrative job after high school which required preparing reports on a “computer”, a “new thing” for her and seemed “more advanced than a typewriter”.

A fascination with technology (40%) was the second main factor for students to get attracted to computers. Here, again, more male (66%) than female (44%) students cited instinctive interest to tinker with the machine (Table 1). As this male student declared, “I have always been interested in computers. There is no story of how I became interested, I just always was”. Another declared, “I grew up around technology since I was really young. So, I was drawn to electronics and computers”. This male student had been taking “toasters to radios apart to know how everything worked. So the computer interested [him]”. Interestingly, female students’ fascination with technology tended to emerge while assisting others. As this female student narrated, “My mother is a high school teacher. Somehow she got involved in the Adventures in the Super Computing Challenge. I kind of helped her get the program started. I did not really like it at first, but I could do it, and that really fascinated me”.

Table 1 shows family members being influential in drawing students’ attention to computers as the third factor. Table 1 also reveals some differences between female and male students; out of 39% students, 54% females and 46% males gave credit to their family members. Interestingly, male students were likely to praise their fathers more than any other family members. As this male student proclaimed, “My dad is a computer nerd … he pushed me to computers”. Another thanked his father for taking him to “‘Bring Your Children to Work Day’ and showed all types of computers”. In contrast, female students were inclined to be grateful to their mothers more than any other family members. As this female student acknowledged, “It was my mother, who said computers are the way to go”. Another felt that her mother “pushed [her] to computers”.

A small number of students also recognized people other than family members guiding them towards computers. Here the difference between female and male students is significant. As Table 1 illustrates, out of 11% students who picked non-family members as making them attentive to computers, 59% were males and 41% were females. Interestingly, more male students mentioned teachers, whereas more female students mentioned friends. For example, one male student appreciated his "elementary school teacher [who] ... purchased a computer with his own money for the school. It was an ancient computer, but at that time it was the best". This female student was grateful to her "boyfriend who showed [her] all sorts of stuff which computers could do".

The remaining factors which generated students' interest in computers, as Table 1 shows, are rewards associated with computers (31%) and applications of computers (28%). More female (59%) than male (41%) students pointed out rewards from computers such as "promising career", "excellent job opportunities", "good money", "flexible work", and "great future". As this female student believed, "The job market is good in computers. I just do not mean the pay scale. It is something that every company needs". Similarly, another noted, "Everything is related to computers in one way or the other. So, the chances of you being unemployed are low". With respect to computer applications, there were minor differences between female and male students (52% versus 48%). Most students mentioned various functions which a computer could perform and expressed their desire to learn how to "make them work a bit better". As this female student noted, "I really liked the diversity. You could create games, do graphic design, or use as some sort of communication tool". A female student loved computers since they "just have a very big window and [one] could pick whatever [one] wants". A male student simply found that "computers were rather cool. They performed complicated functions with just hitting the keys".

Computers at home

Students' responses were coded into two categories: yes and no. Statements were coded only once in a single category. The "yes" category was used if students stated there was a computer at home for them to use while growing up and the category "no" was used for students that responded there was no computer at home for them to use while growing up.

The second hypothesis predicted that female and male students would differ significantly in access to computers at home while growing up. Table 2 gives χ^2 value of 9.000, with a very small p-value (0.003) for $df = 1$, which is significant at $\alpha = 0.05$. It shows that gender strongly influences students' access to computers at home, thus confirming H_2.

Table 2 exhibits that a large majority of students (60%) had access to a computer at home. However, more male (60%) than female (40%) students stated this to be the case. A significant number of students (40%) did not have access to a computer at home. Here, more female (65%) than male (35%) students experienced this situation. This male student confirmed his easy access to computers at home, "Yes, we had maybe three computers in the house". Another echoed, "We got our first computer when I was in the fifth or sixth grade". In contrast, female students talked about the absence of a computer at home. As this female student announced, "No, my family did not have a computer". Another expressed her resentment, "I did not grow up around computers. My parents never had one, and never will". A female student regretted that her family "did not see a use for computers to have them at

Table 2. Access to a computer at home.

	Total respondents (n = 150)		Respondents by gender			
			Female		Male	
Access	n	%	n	Conditional %	n	Conditional %
Yes	90	60	36	40	54	60
No	60	40	39	65	21	35

Note: Statistical significance H_2: $\chi^2 = 9.000$; $p = 0.003$; $df = 1$.

home". Another complained, "My brother had one in his room, but he never allowed me to touch it. So, I never used one at home".

It should be noted that often students had access to old and dated computers which made them feel like they really had not used a real computer while growing up at home. As this male student put it, "We had a really old computer. I do not consider that to be my first experience with computers". Another shared a similar view, "We had an 80/80 computer, but not a real computer". A male student narrated, "We had a black and white TV and a keyboard. The data used to be plugged in from the tape recorder. We had to call lines". This female student remembered having a "real old-time punch card computer [which] allowed [her] to key in the punch cards" but not to have an "interaction with a computer". A female student found her home computer "to be very primitive. One could hardly do anything on it".

Most of the students who had access to a computer at home used it for recreational activities and for word processing, as they grew older. As this male student spoke out, "I used mine mainly for playing computer games". Another mused, "We did not have any graphical interface, so we used computers for playing games". A male student regretted, "I did not do anything important on computers, just toyed with them". This male student summed up how the computer was utilized at this stage, "I had a personal laptop and it was mostly for gaming. I did home work on it. I had experience with stuff like word processing, but I had not done any programming or stuff before". Similar stories were told by female students. This female student, who had her own computer at home, could barely remember what she "used it for" other than "type up an essay or something for school". Another reported that "in elementary school, I used computers to play games. In middle school, I used them for homework. In high school, I used them for doing papers".

Interestingly, there were some variations in students' responses about the family members' use of computers. Generally, male students tended to talk about how their fathers were utilizing computers at home. As this male student affirmed, "My father worked for Boeing, so he brought a lot of work home". Another believed that his "father was very much into computers". A male student stated, "My dad used computers for his business. My mom knew how to turn one on and had no interest whatsoever in it". Some female students, on the other hand, found their mothers to make use of a computer at home as well. As this female student discovered, "It was guys that did computers, but my mother knew how to use a computer". Another showed her appreciation as follows: "My mom kept a computer around, mostly for her work that she brought home. Plus, she bought games and software for me and my sisters when we were growing up".

Computers in the high school

Students' responses were coded into three categories: good access, limited access, and no access. Statements were coded only once in a single category. The category of "good access" included remarks which showed having the opportunity to utilize computers without any constraint. "Limited access" consisted of comments which conveyed constrained physical availability of computers due to quantity, duration, location, currency of technology, and the support system. Terms which indicated that the high school did not have computers for students to use are placed under the "no access" category.

The third hypothesis predicted that female and male students would differ significantly in the accessibility of computers in high school. Table 3 gives χ^2 value of 5.108, with large p-value (0.078) for $df = 2$, which is insignificant at $\alpha = 0.05$. It means that there are few gender differences in access to computers in high school, thus rejecting H_3.

Table 3 demonstrates that a large majority of students (82%) either had good access (42%) or limited access (40%) to computers in their high schools; only a small number of students (18%) had no access to computers. Among those students who responded positively to having good access to computers at their high schools (42%), there were minor differences between male (52%) and female (48%) students. This male student was upbeat about his experience in high school, "At the academy, they had scattered computer pod-labs all over the campus. They were unique in that they had Internet access. They were available before everybody else had them". Another, who went to a public school, had a similar experience, "They had 50 computers and about 20 of them were Macintosh. After the first year, they switched computers to PCs. Windows are pretty well developed in both operating systems". Most importantly, male students showed their excitement for the "programming classes" offered at their high schools. This male student admired his high school for "offering technical classes and teaching computer applications, Pascal, and C+ +". Another bragged that his "high school even had a programming competition". A male student joined "the computer club" in his high school which offered "C+ +". Female students, on the other hand, tended not to be very specific in describing the kind of computer resources they had access to. As this female student mentioned rather casually, "Yeah, we had three computer labs that were open to anybody and a lot of classes had computers". Another believed, "It was a kind of requirement to have a computer lab. So they did".

Students' characterization of limited access (40%) with computers in their high schools varied from few computers to lack of proper programming classes. There

Table 3. Computers in the high school.

	Total respondents ($n = 147$)		Respondents by gender			
			Female		Male	
Availability	n	%	n	Conditional %	n	Conditional %
Good	62	42	30	48	32	52
Limited	58	40	26	45	32	55
No	27	18	19	70	8	30

Note: Statistical significance: $\chi^2 = 5.108$; $p = 0.078$; $df = 2$.

were more male (55%) than female (45%) students who reported limited access with computers in their high schools (Table 2). This male student believed, "Computers were only available in the library". Similarly, this female student complained, "Just one computer class was offered, that was it". Another condemned, "There was a computer lab which we were not supposed to go in, unless a teacher was there, and there was hardly ever a teacher there". A male student grumbled, "The only way you could use computers was if you were in the computer class". A female student was discouraged since the "computer class only talked about how technology was changing". This female student made fun of her high school, "They allowed us to sit in front of a computer to do some minor things and still they used to run into some kind of problems". Similarly, a male student did not like that they "had one computer lab that was strictly used for teaching word processing and not for teaching any programming". Another expressed his annoyance since "there was only one computer programming class and it was a very short class".

Out of a small number of students (18%) who believed that computers were non-existent in their high schools, as Table 3 demonstrates, there were more female (70%) than male (30%) students. One female student spoke loudly, "We did not have any computers". One reason given for the absence of computer resources in high schools was the time period; some of these students attended high schools when computers were not widely diffused. As this female student explained, "Gee, when I was in high school they were just coming out with them ... they were not there". Another regretted that during her time "there were no computer labs at all, unlike today". A female student clarified, "When I was in high school, it was still the 1980s, and in the '80s computers were not so popular". Another reason for the deficiency of computers in high schools was due to the geographic location; some of these students attended high schools either in a poor neighborhood or in a rural area. A female student revealed that "my tribe had zero computers. My high school had zero computers. All they had were some typewriters". Another remembered "a teacher using pictures to say, 'This is a keyboard, this is a mouse, this is a screen', [etc]". Similarly, a female student who went to an inner city high school whispered, "We did not have computers. All we had were books and magazines that talked about computers".

Preparation for college

Students' responses were coded into three categories: limited preparation, no preparation, and full preparation. Statements were coded only once in a single category. The "limited preparation" category consisted of statements which conveyed that students were prepared somewhat through mathematics and science classes and/or selective use of computers. The category of "good preparation" included remarks which made students feel confident that they were fully prepared mostly due to computer classes offered, but also due to mathematics classes in their high schools. Students who indicated that their high schools did not prepare them at all due to lack of computers, classes, and/or teachers were assigned to the category "no preparation".

The fourth hypothesis predicted that female and male students would differ significantly in their perception in degree to which high school classes prepare them to study CS/CE at the college level. Table 4 gives χ^2 value of 5.946 with small p-value (0.051) for $df = 2$, which is close to be significant at $\alpha = 0.05$. This suggests a gender disparity in preparation level in high school for future CS/CE study.

Table 4. High-school preparation for computing studies.

Level of preparation	Total respondents ($n = 148$) n	%	Respondents by gender: Female n	Female Conditional %	Male n	Male Conditional %
Limited	72	49	43	60	29	40
No	55	37	24	44	31	56
Full	21	14	7	33	14	67

Note: Statistical significance; $\chi^2 = 5.946$; $p = 0.051$; $df = 2$.

Table 4 exhibits that a large majority of students (86%) believed either their high schools prepared them partially (49%) or did not prepare them at all (37%) for CS/CE study at the college level; only 14% of students felt fully prepared. Among those who were partially prepared (49%), there were more female (60%) than male (40%) students. This was mostly because of what students perceived to be "deficient computer science curriculum" at their high schools. This female student did not really feel prepared "because computer science class was basically a word processing class" and did not "go into programming". Another complained, "There were not that many computer classes offered and they were mainly for beginning typing, or graphic design" but "nothing in depth". This female student raised the same concerns: "The only thing we did on computers was Power Point. We did not really learn programming in the high school. So, they did not help me directly. But, my high school taught me a lot of math. So, they helped me indirectly".

A significant number of students (37%) believed they were not prepared at all for CS/CE study at the college level. Table 4 shows this to be the case with slightly more male (56%) than female (44%) students. Students felt unprepared because of lack of computer resources, unqualified teachers, and mediocre curriculum. This female student was not happy since "the math in [her] high school was minimal, mainly geometry. Teachers did not encourage [students] to do a lot of math and sciences". Another noted, "No. There were no computer science classes. Math is a big part of computer science in some ways. That was not there either. I heard rumors that they were going to offer calculus the year after I graduated". This female student got frustrated when she came to college, "I had no background at all in programming. I felt way way behind". A female student found her high school lacking in "qualified teachers to teach computer science and math". This female student was clear, "No. I cannot say a lot of nice things about the math in my high school. It was pretty minimal. It was like in order to graduate you have to take geometry. And, that is all you have to take. They did not encourage math, at least to me".

Table 4 demonstrates that only a small number of students (14%) felt fully prepared for CS/CE study at the college level. Table 4 also shows that significantly more male (67%) than female (33%) students stated this to be the case. Almost all students attributed their good preparation to programming and mathematics courses they took. A male student retorted, "Yes. I was proficient in C and C + programs before I came here". The same sentiment was echoed by this male student, "The computer classes at my high school were at a very high level and the math courses were rigorous". A male student was thankful, "We had extra classes mainly geared towards computer science, with additional mathematics like Calculus I and II". It should be noted that some Asian American students finished their high schools outside the USA. These students believed training in mathematics was rather rigorous in their home countries than in the USA. As this female student believed, "Math classes are really hard in China. So when I came to the US, it was very easy. And we use a lot of mathematics in computer science". Another felt confident, "I am very good in math and can do any field in engineering and sciences. Math in India is very rigorous and prepares you well for any subject".

Conclusion

This study has shown gendered digital divide. Female students had late exposure to computers both at home and in schools. Though their high schools had computers, they were either few in numbers or not easily accessible. Further, the CS curriculum was rather deficient as it did not go into programming. Most importantly, high-school teachers seldom influenced female students towards computers. Since the sample in this study was comprised of male and female students from five major ethnic/racial groups, namely White, Afro-Americans, Hispanics, Asian Americans, and Native Americans, who were attending minority-serving institutions, the findings point out where the digital divide is experienced the most. There is a need to re-examine institutional factors such as CS curriculum and role of science teachers at high schools in low-income and rural areas. This study has shown that the social and institutional contexts matter.

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Appendix 1. Interview questions

(1) How did you become interested in computers? When did you become interested? What interested you? Who interested you? Where did you become interested?

(2) When you were growing up, did you have a computer at home? If yes, did you use it? What did you use it for?

(3) Were computers available for you to use while you were in the high school? If yes, did you make use of computers? What did you use them for? How easily were they available to you? Where were they located?

(4) Did your high school classes prepare you well to study CS/CE at the college level? If yes, how were you well prepared? If no, what was lacking in the preparation?