

# Women disappearing in Computer Science

Ásrún Matthíasdóttir  
 Reykjavik University  
 Ofanleiti 2, 103 Reykjavik  
 Iceland  
 +354 5996200  
[asrun@ru.is](mailto:asrun@ru.is)

## ABSTRACT

Every society needs the participation of both genders in the development of ICT. Girls and women are using computer systems, computer games and the Internet as well as boys and men, and the invention and development of this technology should be influenced by both sexes. In this paper, a survey conducted at Reykjavik University will be discussed. The findings indicate that young women do not know what computer science is as a subject and do not realise what employment and professional opportunities are for people with a degree in computer science.

## Keywords

**Women, Computer science, students' attitudes, gender differences.**

## 1. INTRODUCTION

Over the past 20 years the number of women enrolling in computer science has been decreasing to such an extent that today the situation is barely acceptable. This trend has been strong over the last 20 years: "The percentage decline in computer science was much larger among women (51 percent) than among men (28 percent) from 1985 to 1995" [5] (p. 2). Despite an increase in the percentage of women graduate students, they are less than 25 percent of computer science graduates [10]. Kahle and Schmidt [6] emphasise that "Even though computer science offers a great deal of professional opportunity, statistics show women have not been taking advantage of its many benefits." (p. 78).

Every society needs the participation of both genders in the development of information and communication technology (ICT) and not only men. Girls and women are using computer systems, computer games and the Internet as well as boys and men and the invention and development of this technology must be influenced by both sexes.

A few studies have been looking into women's interests in computer science with the intention of increasing their number in the field. The Carnegie Mellon School of Computer Science, for instance, succeeded in increasing the number of female computer science students from 7% to 42% in the period between 1995 and 2000 [8]. An

important factor in this dramatic increase at Carnegie Mellon was a change in the curriculum which allowed students to choose between four different approaches to computer science studies based on their previous computer experience. The school also changed its selection criteria. Instead of focusing solely on academic achievement, more attention was given to factors such as independence, creativity and dynamism. Financial position, race and gender were also considered. These changes in selection criteria did not affect the average grade at the school. In order to encourage interest in computers among schoolgirls, Carnegie Mellon held courses for high school teachers in C++, and methods for making computer studies an attractive option for young women at this level.

The University of Skövde in Sweden has managed to increase its number of female computer science students from 10% to 40% in only three years [3]. This was made possible through the design of a new study option where ICT and computer science were interweaved with social sciences and humanities and where mathematics only came in as support material where applicable. Women have shown a greater interest in this course than other existing options at the Skövde University.

At Stanford University, studies have been conducted to investigate why so few women apply for postgraduate courses in computer science and become faculty members [1]. These studies revealed no gender imbalance within the University. The primary reasons were found to be a lack of interest and motivation from the environment (mainly parents). Other reasons include long and irregular working hours which may affect private life, different gender attitudes towards the field of computer science and a lack of self-confidence and role models. Women do also have less access to computers in childhood, frequently display more negative attitudes towards computers than men, and often have less computer experience than men when they enter university [1].

Maria Enderton [9] has made an interesting study of the effects of stereotypes on women in computer science and one of her conclusions is that "...the gender stereotypes and negative attitudes towards women in the computer science environment are internalized, resulting in decreased interest and confidence" (p. 57).

In Iceland the access to computers is quite common as 90% of Icelandic households had a computer in 2005, 84% had access to the Internet, 88% of all individuals at the age of 16–74 years used a computer and 86% were Internet users [4].

Following the drop of female students in computer science at Reykjavík University (RU) from 31% in the year 2001 to 11% in the year 2003, a study was conducted during the summer of 2003 in order to investigate the possible reasons for this development. The aim was also to survey student attitudes and possible gender differences in attitudes towards the computer science courses and course materials on offer at RU. Some of the findings will be described in this paper, but the results of this study have been published in an Icelandic report [7] and some of the results have been discussed in conference proceedings in Iceland 2003 and published in an Icelandic journal [2]. The study was partly funded by the Student Innovation Fund in Iceland (Nýsköpunarsjóður námsmanna [www.nsn.is](http://www.nsn.is)). Kolbrún Fanngeirsdóttir a computer science student and Hrafn Loftsson the computer science department dean at that time did take part in the study along with the author of this paper.

The study described here was divided into two sections; 1) a web-based survey that was designed and presented electronically to students at RU and 2) female students at the University were interviewed. The main focus of the present paper is on the results of the web-based survey.

## 2. METHODS

Participants in the survey were three groups of students at the Reykjavík University (RU) in Iceland in 2002; 1) present male and female students at RU's School of Computer Science (CS), 2) prospective students in CS and 3) female students at the Schools of Business (BU) and Schools of Law (LW). Web-based questionnaires were specially designed for this study and although the main questions were the same for all groups some had to be different so three different version of the questionnaire were made, one for each group of students. The questions were divided into three main categories:

- a) Questions about the participants' background.
- b) Questions about use, access and computer knowledge.
- c) Questions about the computer science courses.

The questionnaires were completed online at a web site in June 2003 with the web-survey program Outcome ([www.outcome.is](http://www.outcome.is)). After eliminating all inactive e-mail addresses, the survey was sent out to 867 participants and kept open for a month. The response rate was generally good yielding a total of 539 (62%) replies. Male students in CS were 151 (28%), female students in CS were 88 (16%),

female students from BU and LW were 239 (44%) and new students in CS were 61 (11%). The response rate was much higher for females at CS (85%-100%) than males (47%-78%).

Furthermore, interviews were conducted with 10 female students at RU, but the results from the interviews will not be discussed in this paper. The main focus here will be on answers from students in CS.

## 3. RESULTS

### 3.1 Access and use of computers

If we first look at access to computers, it is clear that male students at CS gain access to computers at an earlier age than their female counterparts, both at home and at school, the home access being on average 2.8 years earlier as Table 1 shows. Female students at CS gain computer access at comparable ages at home and at school, whereas male students are given computer access 1.4 years earlier at home than at school. The gender difference appears to be greater among freshmen. This difference should however be interpreted with caution owing to the small number (11) of female freshmen in the study. Female freshmen are on average 18.7 years old when they gain access to computers at home, which is considerably older than the male students.

**Table 1. Computer Science (CS) students' access to computers.**

Computer access	Male	Female	Difference
<b>Computer access of current computer science students</b>			
<b>At home</b>	14.0 years	16.8 years	2.8 years
<b>At school</b>	15.4 years	16.6 years	1.2 years
<b>Computer access of computer science freshmen</b>			
<b>At home</b>	13.8 years	18.7 years	4.9 years
<b>At school</b>	16.8 years	16.2 years	0.6 years

The average age at which female students at BU and LW gained computer access at home and at school was 17.4 years, which is a little later than for women at CS.

Figure 1 shows the proportion of current students at CS having used computers for programming, examining hardware and playing computer games while at primary or secondary levels of education. Here is a marked difference between the genders, being greatest for examining hardware, 4% of the females and 32% of the males claiming to have used computers for examining computer hardware, and using computers for programming, which 6% of the females and 23% of the males claimed to have done.

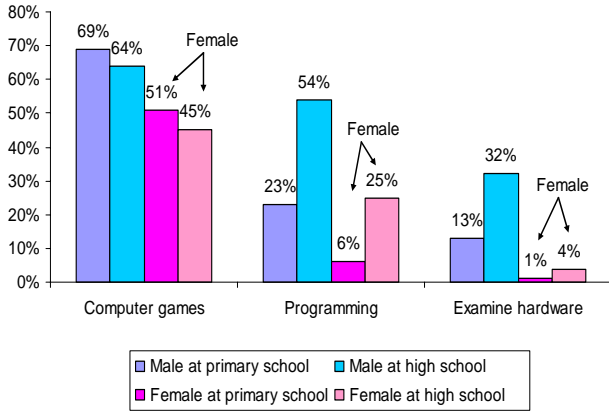


Figure 1. Current CS student computer use in primary and high school.

### 3.2 Computer knowledge and interest

There appears to be a marked difference in students' computer knowledge before attending university. As Figure 2 shows, 58% of the males in CS considered themselves to have good or very good knowledge of computers, while only 25% of the females claimed they did. Only one freshman at CS claimed a little computer knowledge, all other freshmen rated their computer knowledge as average or better as Figure 2 shows.

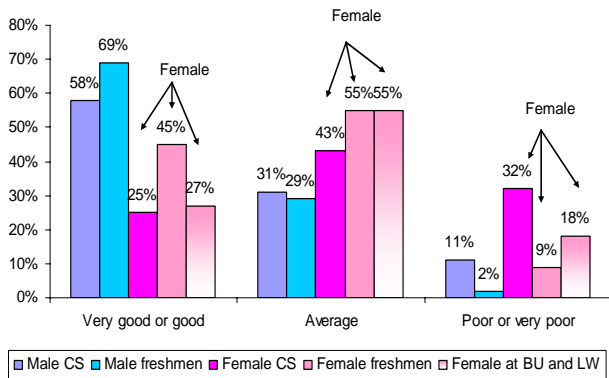


Figure 2. Student ratings of their computer knowledge before attending university.

Figure 3 shows, that the males clearly developed an interest in computer science much earlier than the females. Forty-five per cent of current male students at CS became interested in computers before the age of 19 whereas only 20% of the females developed this interest before that age. As shown in the graph, there is hardly any discernible difference between freshmen and more advanced students.

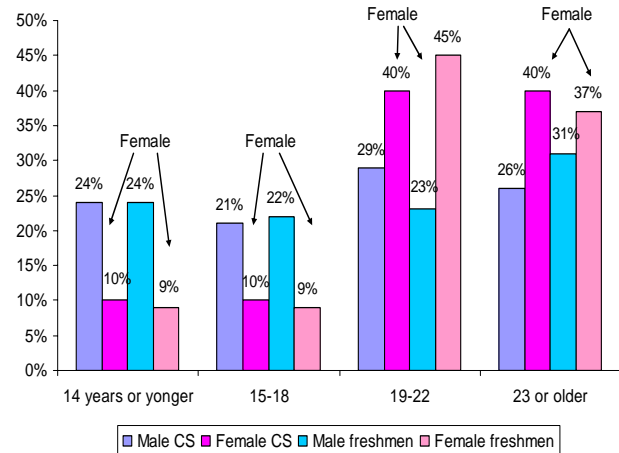


Figure 3. Age at when CS students first developed an interest in computer science.

### 3.3 Reason for choice of computer science

Table 2 describes the various reasons the current students at CS gave for their choice of computer science. Most of them gave more than one reason and there is little difference between the genders apart from the following two reasons: 1) 72% of the male students choice computer science because of an interest in computers, compared with 39% of the female students. 2) Only 21% of the male students said they had chosen computer science just to try it out, whereas nearly half the female students (49%) said they did.

Table 2. Why current CS students chose computer science as a topic in University.

	Male CS N (%)	Female CS N (%)
Interesting subject	121 (80%)	80% (72%)
Well paid	75 (50%)	50% (57%)
Job prospects	65 (43%)	43% (56%)
I am interested in computers	108 (72%)	72% (39%)
I am good at math and science	64 (42%)	42% (55%)
I did well in computer courses at high school	62 (41%)	41% (38%)
I just wanted to try	31 (21%)	21% (49%)
A varied subject	57 (38%)	38% (34%)
I would like to use my knowledge of computers in other areas of interest	44 (29%)	19 (22%)
I was encouraged by others	21 (14%)	19 (22%)
There has never been anything else	21 (14%)	6 (7%)
Something else	11 (7%)	14 (16%)

Freshmen did not express the same reasons for choosing computer science as current CS students did. For instance, 55% of the freshmen claimed to have chosen computer science in order to apply their knowledge to other areas of interest, whereas only 26% of the current students did. Fewer freshmen chose computer science because of good wage prospects, or 37% compared with 53% of the current CS students. Similarly, fewer freshmen (6% male and 18% female) said they had chosen computer science just to try, compared with 21% of the male students and 49% of the female students currently studying at the School of Computer Science, as shown in Tables 2 and 3.

**Table 3. Why freshmen at CS chose computer science as a topic in University.**

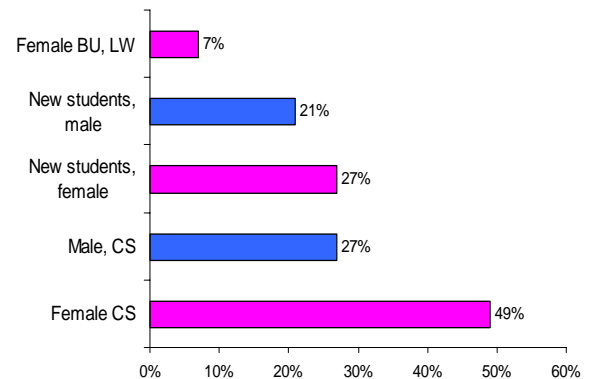
	Male CS	Female CS
	N (%)	N (%)
<b>Great interest in computers</b>	40 (82%)	7 (64%)
<b>Interesting subject</b>	28 (57%)	7 (64%)
<b>I would like to use my knowledge of computers in other areas of interest</b>	26 (53%)	7 (64%)
<b>Job prospects</b>	17 (35%)	6 (55%)
<b>I did well in computer courses at high school</b>	19 (39%)	4 (36%)
<b>Well paid</b>	21 (43%)	1 (9%)
<b>I am good at math and science</b>	16 (33%)	3 (27%)
<b>A varied subject</b>	11 (22%)	2 (18%)
<b>I was encouraged by others</b>	9 (18%)	3 (27%)
<b>There has never been anything else</b>	7 (14%)	0 (0%)
<b>Just wanted to try</b>	3 (6%)	2 (18%)
<b>Something else</b>	4 (8%)	1 (9%)

The principal reasons why females at BU and LW did not choose computer science were an overriding interest in the subject they were currently studying (45%) and a lack of interest in computers (40%).

### 3.4 New course option

A special study was made of whether current CS students, as well as freshmen, were interested in a course option within the department interweaving computer science with social sciences and the humanities. Between 34 and 54 percent of the students claimed they did not know, but CS students showed an interest in such a line as Figure 4 shows, particularly the female students. About half (49%) of them showed an interest in this kind of option and only

17% claimed they were not interested. Nearly one third of the male CS students (27%) showed an interest in the idea.



**Figure 4. Interest in courses interweaving computer science with social sciences and the humanities.**

## 4. DISCUSSION

The main conclusions of this survey are that women lack general knowledge about computer science, do not know what the subject entails or the opportunities it creates. The women participating in this survey also appear to have less experience of computers and computer science subjects than men before coming to university. The results of the survey also suggest a gender difference in the access to computers, as men seem to gain computer access at a much earlier age both at home and at school. This may affect women's motivation and interest in computer science and one of the ways to reverse this trend - as suggested by a study conducted at Stanford University - is to introduce young girls to computers and computer science as something that is fun to deal with in order to motivate them [1].

The gender difference in computer usage at the primary school level as well as in high school further supports the hypothesis that women lack basic understanding of computer science. Another argument in support of this hypothesis is the fact that around half the women studying at Reykjavík University's School of Computer Science claim to have chosen this field of study simply in order to see if they could manage it, which also indicates that they do not have enough previous experience of computers and computer science.

The students' ideas on promotional activities are compatible with the methods currently applied, although these activities may need to be geared more towards younger students. Reykjavík University could play a leading role in this by emphasising the promotion of computer science to girls from primary school level and up, thus enabling them to reach informed career decisions based on experience and knowledge.



The possibility of organizing a new line of study at Reykjavík University with a special emphasis on interweaving computer science with social sciences and the humanities is worth considering. Nearly half the female students at CS declared an interest in such a line of study. A large proportion of respondents, however, were somewhat undecided – possibly owing to the fact that the proposed line of study was not described in any detail in the survey. This interest is compatible with the experience gained at the University of Skövde which was mentioned in the introduction and which may be used as a basis for new developments in Iceland [3].

A few points in this survey did not work out as planned and may thus affect the results. The format of three questions to current CS students was for instance flawed in such a way that the replies were deleted and could therefore not be used. The timing and length of the questionnaires, however, does not seem to have affected the response rate, which was generally rather good. It should also be borne in mind that relatively few answers came from some of the groups. This applies in particular to the group of freshmen, which is exceptionally small, with only 11 female and 50 male respondents. Therefore the results need to be viewed with some caution.

This survey gives rise to a number of questions for further research, for instance offering a new line of computer science as described above and also how best to promote computers and computer science to girls at an earlier age so that they will not enter university just to see if they can manage but will be able to make their choice because they know the subject and the opportunities it creates.

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