

# Why Students with an Apparent Aptitude for Computer Science Don't Choose to Major in Computer Science

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## ABSTRACT

The statistics show that the number of Computer Science majors is dropping across the United States. Possible reasons include a reduced number of jobs in the field, an incorrect perception of what Computer Scientists do, and the students' disinterest due to a lack of familiarity with the subject. The reasons may be different for males and females. This paper reports on a study in which 836 high school calculus and pre-calculus students were surveyed to try to determine why students with an apparent aptitude for CS did not pursue a major in Computer Science. The results supported some of the hypotheses for declining enrollment, and rejected others. The top reasons for rejecting the major were the same for both genders, but the reasons for choosing the major differed.

## Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computer and Information Science Education - Computer Science Education, Curriculum, Literacy K.7.1 [The Computing Profession]: Occupations

## General Terms

Experimentation, Human Factors, Verification

## Keywords

High School Computer Science Education, Computer Science Major, Gender Issues in Computer Science, Declining Computer Science Enrollment, Definition of Computer Science.

## 1. INTRODUCTION

There is a growing concern about the reduction in students choosing to study computing. Recent reports have shown that the number of incoming college freshmen specifying Computer Science as a major has dropped 60% over the last 4 years [14]. Top universities such as Carnegie Mellon, Rutgers, Stanford, and the University of California, Berkeley report significantly fewer

applicants and fewer degrees awarded in Computer Science in recent years [7]. Several hypotheses exist as to why. Some say that students entering universities don't choose the major because outsourcing and the dot-com bust has eliminated the monetary attraction to Computer Science [10]. Others say that the image of Computer Scientists being programmers that sit in front of a computer all day is not appealing [6]. Still others declare that the reasons are different depending on the gender of the student [5,13].

Another hypothesis, based on anecdotal evidence seen at Point Loma Nazarene University (PLNU), is that students, male or female, don't pursue education in computing fields because they either have no information or incorrect information about what the study of computing involves and what sorts of careers are available to computing professionals. Students choose to major in areas where they feel confident and comfortable. Most High School students are not introduced to Computer Science. They are required, or strongly encouraged, to take classes in Math, History, English, Art, Music, Physics, Biology and Chemistry, but not Computer Science. Experience has shown that when freshmen are properly introduced to Computer Science, they are attracted to it, even to the point of changing their majors.

This paper presents the results of a survey administered to 836 High School students (363 men, 423 women, 50 declined to say) from nine different schools in California and Arizona, to try to determine if any of the hypotheses could be substantiated. Because research has shown a strong correlation between success in Computer Science and success in Math, Calculus and Pre-Calculus students were targeted to answer the question, "Why do students with an apparent aptitude for Computer Science not consider it as a future major, and are the reasons different for males and females?" Section 2 presents the background of, and motivation for the study. Section 3 describes the survey and the participants. Section 4 follows with the survey results and Section 5 provides a discussion of the implications of these results.

## 2. BACKGROUND AND MOTIVATION

PLNU is a small liberal arts university in San Diego where the Math and Computer Science majors are housed in the same department. The faculty believes that it is extremely important for Math majors to be competent programmers. Consequently, all students in the department have been required to take the Introduction to Computer Science and Introduction to Computer

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*SIGCSE '06*, March 1-5, 2006, Houston, Texas, USA.

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## 4. RESULTS

The analysis of the survey results showed that High School students are severely lacking in experience with computing, particularly in formal classroom experience. The vast majority of students had no concept of what a Computer Science major entails. The top reasons for not choosing a CS major for both male and female were the lack of desire to sit in front of a computer all day, and the fact that they had already chosen another major. The number one reason to choose a CS major for men was their interest in computer games, and for women was their desire to use it in another field. The students' understanding of the amount of money to be made in the field was not a significant influence in the choice not to study Computer Science. A more detailed discussion follows.

### 4.1 Computer-Related Experience

This survey looked at two kinds of experience: that gained from formal classes, and that which was self-taught. The experiential results come from survey questions 2 and 4. The number of students with each kind of experience is shown in figure 2.

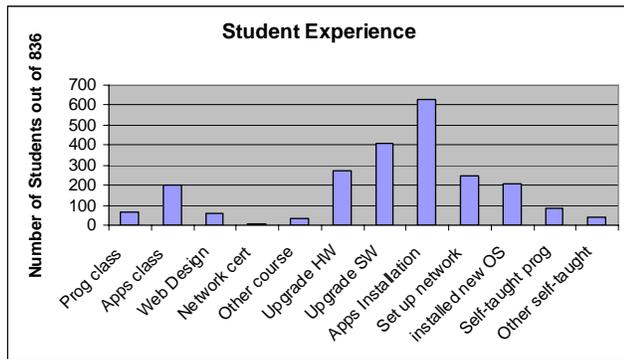


Figure 2. Student experience

The first 5 categories reflect classroom experience, and the later 7 reflect results for informal or self-taught experience. The most common submissions for "other" coursework were Computer Graphics and Computer Animation, and for other informal experience were HTML, JavaScript, Flash and building a computer. Of the 836 students surveyed, 13% of students had no experience (formal or informal) whatsoever. Informal experience is much more prevalent than formal coursework, with only 33% of the students having any formal education. Most often, the one class the students had taken was Computer Applications (Word Processing, Spreadsheets, etc.) Some students indicated that this formal class work was part of their middle school education. The percent drops to 8% when the number of students taking more than 1 formal class is considered.

Application installation and upgrading were the most common forms of experience. Less than 1/3 of the students had any experience beyond software use and installation. Less than 15% of the students claimed any programming experience, either formal or informal.

### 4.2 Understanding of CS

The final survey question was open-ended. The students were given the opportunity to give their impression of what Computer

Science students learn. They were given the option to leave the answer blank if they had no idea. The major categories depicting the responses were: 1) programming 2) networking 3) advanced computer use 4) computer repair or building computers 5) how computers work 6) "computer stuff" or "everything about computers" 7) good understanding. The answer was categorized as a 7 if the student demonstrated an understanding that the field could contain more than writing and using programs, and installing hardware. If they also included the ideas of hardware design, problem solving, combining computer knowledge with another field etc., the answer was designated as a 7. Unless the answer was designated a 7, the response could have been assigned more than one category. The results are shown in figure 3.

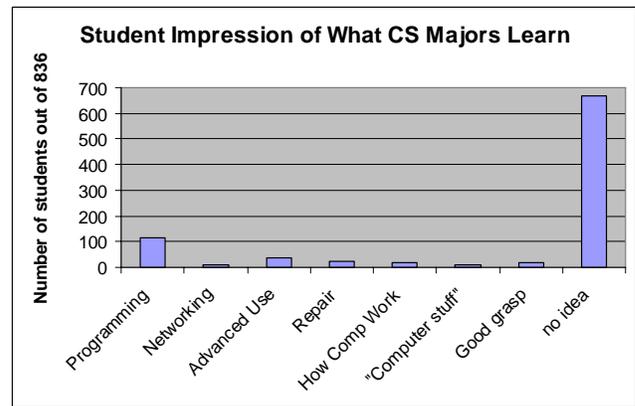


Figure 3. Computer Science major defined

An alarming number of students (80%) had no idea what Computer Science majors learned. Of the students who did give a response, most believed that the major focused on computer programming. Only 2% of the high school students surveyed had a reasonably good grasp of what the field of Computer Science entailed.

### 4.3 Positive and Negative Influences

Figure 4 displays the number of students who indicated each factor as an influence **against** Computer Science as a major. The responses reported came from the 828 students who indicated that there was a possibility that they would attend a 4-year university.

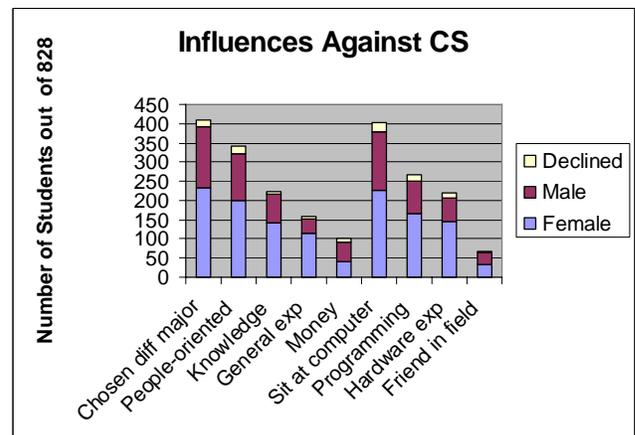


Figure 4. Influences against choosing a CS major

In a later section it will be interesting to look at the differences between the responses of males and females. Consequently, a stacked-column graph is used to differentiate the responses between male, female, and those that declined to answer the gender question. The graph clearly shows that finances are not the primary reason for students to stay away from a career in computing.

The top three negative influences appear to be an aversion to sitting in front of a computer all day, the fact that they are already sold on another major, and that they would like a more people-oriented major or occupation. Programming came in a distant fourth on the list of negative influences, although it is important to note that only 11% of the students listing programming as a negative had any experience, either formally or informally, with programming.

Figure 5 depicts the college-bound students' ideas regarding the factors that would have a **positive** influence on choosing Computer Science as a major. The number one reason that caused people to think they might consider Computer Science is the ability to combine it with another field of interest such as business or medicine. Coming in a close second was the students' interest in computer games, and the third most influential factor was a students' previous experience. The numbers show that 75% of the students who had participated in more than three computer-related experiences saw this experience as positive.

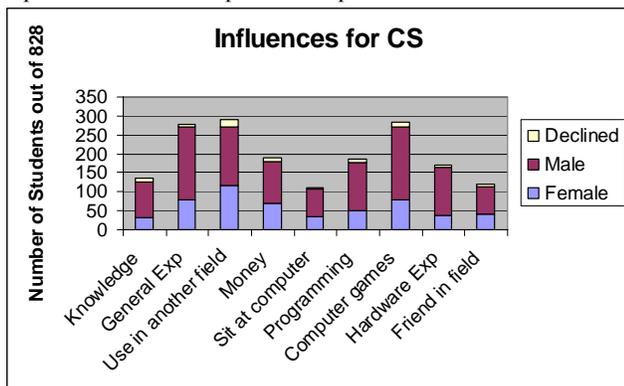


Figure 5. Influences for choosing a CS Major

#### 4.4 Male vs. Female Responses

The difference between the responses of men and women was significant in many areas. In general, the males were much more likely to have had experience. At least one formal class was taken by 40% of the men, and 27% of the women. However, when considering students who had taken more than one formal class, the numbers dropped to 13% for the men, and 3% for the women. Results were similar for informal experience. For the men, 78% had performed more than one activity on their own, and only 41% of the females had done so. The proportion of men citing the amount of experience as a factor against choosing a CS major was significantly different from the proportion of women citing this reason, with women seeing it as a deterrent much more often ( $z=6.245$ ,  $p<0.0001$ ). Probably due to the additional experience, more men were willing to venture an answer to survey question

#9, with 26% of the males and 17% of females providing a description of the Computer Science major.

Although female students found more reasons to reject a Computer Science major, it is very interesting to note that men and women agreed on the three top reasons. The strongest influences against Computer Science for both genders were a lack of desire to sit at a computer all day, and the previous decision to choose another major. The desire for a more people-oriented major was the clear third for both, although the proportion of women felt this way was significantly larger than the proportion of men ( $z=4.233$ ,  $p<0.0001$ ).

The positive influences differed notably for male and female. The first clear difference was that men found a lot more positives than did women. For men, the number one positive influence was interest in computer games, while for women, gaming was third ( $z=10.492$ ,  $p<0.0001$ ). For women, the desire to use Computer Science in another field was the primary motivator towards a major in CS, however this was number three for men.

## 5. IMPLICATIONS

A recent article in Computer Magazine [10] made suggestions for improving Computer Science education. The survey results support several of their suggestions:

- *Offer multidisciplinary and cross-disciplinary programs.* The number one reason for females and the number three reason for males that might influence them towards a major in Computer Science is the desire to use computing in another field. Students need to see that Computer Scientists were involved in mapping the human genome [1] (bioinformatics), hurricane prediction [12] (environmental modeling), and creating a machine to perform Lasik surgery (medicine). As mentioned by [10], if outsourcing is an issue, this would equip students with more specific expertise that is not easily outsourced.
- *Fix computing science's image.* Most students who gave a description of Computer Science saw it as programming or advanced computer use and were rejecting it because they did not desire to sit in front of a computer all day. The educated student would learn that many aspects of Computer Science require significant people interaction. Along with those listed in the previous paragraph, computers are used for special effects in movies, to improve the quality of life for people with missing limbs, and for allowing communication for people with speech impediments [9,11].
- *Increase women's enrollment in CS.* Based on the survey results, a start would be to increase women's awareness of and experience in CS. The results of the survey substantiated the belief that women are initially less attracted to formal CS education. The Seminar that we held at PLNU attracted 16 local youths, and not one was female. In our survey, only 11% of the women said they were even somewhat likely to pursue a major in CS, as opposed to 36% of the men. Females indicate that they want to be with people, they dislike the idea of sitting in front of a computer all day, and they think they dislike programming and hardware although most have no experience with either. As mentioned, at PLNU, all math majors have been required to take the Intro to Computer Science and Intro to Computer Programming

sequence. Initially, this requirement upsets many of our female students, even to the point of tears. However, in the last two years, 6 out of the 10 non-CS women required to take the courses decided to become a TA for the courses for the next year, add a minor in CS, or change their major to CS. All reported that they previously had no idea what Computer Science was.

- *Train high school computing science teachers.* High school students are severely lacking in formal computer science education. Incorporating more classes into the High School curriculum would require the training or re-training of teachers. The vast majority of High School students have no idea what Computer Science is. More classes, and required classes, will allow students to make an informed decision as to whether a major in Computer Science is right for them. The Model Curriculum for K-12 Computer Science [4] suggested by the Computer Science Teachers Association (CSTA) is a good beginning.
- *Make CS courses fun.* The men's top reason for choosing CS a major was interest in Computer Games. However, the women's top reason was to use CS in another field. Consequently, this goal should be restated to say that is it important to make CS courses creative and relevant. The validity of such an idea was demonstrated by the success of the Media Computation course used at Georgia Tech for non-CS majors. In [8], it was reported that many non-CS students, after completing the aforementioned required course, requested more CS courses.

## 6. CONCLUSIONS

The survey results provided evidence to support the belief that students choose not to major in CS because they have an incorrect or no perception of what the field is. A large percentage (50%) of students is opposed to CS because they imagine computer scientists as sitting in front of computers and programming all day. The vast majority of students could not provide a description of what Computer Science majors learn. There is also evidence to support the belief that one of the reasons for this ignorance is the lack of education available to, or required of, High School students. Only 8% of students had taken any formal classes in CS outside of Computer Applications. Training high school computing science teachers should be a priority for the future so that students can be adequately introduced to the field. Women might be more interested if they could see how CS could be used in other fields. This study did not produce any support for the belief that students are rejecting Computer Science for financial reasons.

## 7. ACKNOWLEDGMENTS

Much of the success of this project is due to the work of the survey-takers which include Lauren Fowler, Tyler Gray, Jessica Hill, Danae Imel, Ryan Klauer, Megan Low and Erin Trine. Thank you to Jeff McKinstry and Karen Hoekstra who helped with survey preparation and to Greg Crow who helped with statistical analysis. Michelle Carter assisted with data input. Finally, thank you to the many High School teachers and

principals that allowed the students to administer surveys in their classes and schools.

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