Overcoming Misconceptions about Computer Science With Multimedia

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ABSTRACT

Preconceived ideas about computer science may discourage students, especially females, from pursuing study in the field. Many of these common, but negative stereotypes are misconceptions. We address these misconceptions in multimedia courseware developed for a CS0 or CS1 course covering a breadth of topics in computer science. Experimental results show that the multimedia overcomes negative stereotypes, including a couple that are more pronounced for women.

INTRODUCTION

Women have been making gradual gains in most professions that were traditionally male-dominated, but information technology appears to be an exception--for instance, the number of computer science degrees awarded to women declined from 35.8 percent to 22 percent between 1984 and 2002 [6][12]. Many computer science researchers found that misconceptions about what is computer science and what computer scientists do play an important role in hindering females entering computer science. These misconceptions are 1) Computer scientists lead "solitary, antisocial" lives [9], 2) Computer science is about hardware [7], 3) Mathematical ability is essential for writing programs [7][11], 4) Computer science is all programming [7], 5) Computer science is the study of the uses of software [1][13], and 6) Computer scientists are computer nerds [10][14]. Many women want to work with people [8][11], and consider the first misconception a negative factor in choosing computer science as a career.

With input from a workshop of grades K-12 teachers, undergraduate and graduate teaching fellows, we diagnosed six common misconceptions about computer science. In the framework of the CIMEL project [4], we designed multimedia content (including video interview, animation and interactive exercises) to help students overcome these misconceptions. We then proposed two hypotheses: 1) students taking a first semester course in computer science still have these negative stereotypes and 2) effective multimedia can help overcome these attitudes. Our experimental study compared CS0/CS1 students' attitudes before and after students interacted with multimedia. The results confirm our hypotheses; we also discovered significant gender differences. We plan follow-up studies to see if these effects endure, and also to see whether the results can be duplicated with students in sixth grade.

EXPERIMENTAL DESIGN

Subjects in the experiment are 55 undergraduate students who enrolled in two introductory computer science courses (Survey of Computer Science, a CS0 course for non-CS majors, and Introduction to Computer Science, a CS1 course with more time to be spent on C++ programming). The participants completed a demographic survey (including age, gender, ethnicity, major, and prior experience using computers). Two-thirds of the participants then took a pre-test of ten questions, in which they indicated their level of agreement (on a scale of 1 to 5) with ten statements about computer science and computer scientists. All of the students then completed the multimedia. After completing the multimedia, all participants filled out the post-test, consisting of the same ten statements as the pre-test, in a different order:

1. Computer scientists write programs all day.
2. Computer scientists get to work with lots of interesting people.
3. A strong math background is needed to succeed in computer science.
4. Many computer scientists have poor social skills.
5. Good verbal and written communications skills are important for a successful career in computer science.
6. Computer scientists spend all their time sitting in front of a computer.
7. Computer scientists study how to make computers easier for people to use.
8. Computer scientists need to understand other fields in order to make computers do what their users need them to do.
9. A career in computer science would be dull and boring.
10. Most computer scientists spend a lot of time building newer and faster hardware.

DATA ANALYSIS AND DISCUSSION

In Table 1, each pretest mean is the mean value of 38 answers for each question, and each post-test mean is the mean value of 55 answers for each question. All but three items (7, 8, and 9) are significantly different from the pretest to the post-test and all in the expected direction—the multimedia has the positive effect of overcoming these misconceptions ($p<=0.01$). The mean scores for the questions on the pretest showed that the misconceptions did exist. The significant effects showed the CIMEL multimedia helped the students overcome the 7 misconceptions. The three questions which do not show significant change were addressed only incidentally by the multimedia. Statements showing the first, second and third highest gain are statement 3 "A strong math background is needed to succeed in computer science", statement 1 "Computer scientists write programs all day" and statement 6 "Computer scientists spend all their time sitting in front of a computer". These 3 statements correlate directly to the explicitly-stated misconceptions in the multimedia.

In Table 2, 40 respondents were male and 15 were female. On most questions the females scored higher than the males on both the pretest and posttest, and showed a greater gain for those questions where the pre- and post-test differences were significant. On two questions, "work with interesting people" and "spend a lot of time building hardware," females scored significantly lower on

the pretest than males, but showed a much larger gain on the posttest (see rows 2 and 10 in Table 2, p<.01 in both cases). Also female students tend to stay longer in multimedia lab than males, and that *all* unsolicited favorable comments about the multimedia come from female students. From our findings effective multimedia helping female students to overcome misconceptions may be an important clue about how to widen the "incredibly shrinking pipeline" for women coming into computer science [5].

Table 1 Pretest of 38 students and Posttest for 38+17 students

Statement	Pretest Mean	Posttest Mean	Mean Post-Pre	Significance (p)
1. Programming	2.71	1.97	-0.74	0.001
2. Interesting people	3.24	3.82	0.58	0.001
3. Math background	3.84	2.45	-1.29	0.001
4. Social skills	2.61	2.05	-0.56	0.001
5. Communication	3.50	3.92	0.42	0.005
6. Time at computer	2.92	2.18	-0.74	0.001
7. Easier to use	3.97	3.84	-0.13	0.418
8. Other fields	4.16	4.37	0.21	0.160
9. Boring career	2.37	2.16	-0.21	0.088
10. Hardware	3.00	2.45	-0.55	0.001

5=Strongly Agree; 4=Generally Agree; 3=Sometimes Agree; 2=Generally Disagree; 1=Strongly Disagree Maximum possible score was 5.

Table 2 Pre-test means of 9 female and 29male students and Post-test means for 9+6 female and 29+11 male students

	Female			Male		
S	Pretest Mean	Post-test Mean	Mean Post-Pre	Pretest Mean	Posttest Mean	Mean Post-Pre
1	2.22	1.44	-0.78	2.86	2.14	-0.72
2	**2.89**	**3.89**	**1.00**	**3.34**	**3.79**	**0.45**
3	3.67	2.11	-1.56	3.86	2.55	-1.21
4	2.22	1.78	-0.44	2.72	2.14	-0.58
5	3.67	4.33	0.66	3.45	3.79	0.34
6	2.67	2.00	-0.67	3.00	2.24	-0.76
7	3.78	3.78	0.00	4.03	3.86	-0.17
8	4.33	4.33	0.00	4.10	4.38	0.28
9	2.33	2.11	-0.22	2.38	2.17	-0.21
10	3.22	2.00	**-1.22**	2.93	2.59	**-0.34**

5=Strongly Agree; 4=Generally Agree; 3=Sometimes Agree; 2=Generally Disagree; 1=Strongly Disagree Maximum possible score was 5.

These results confirm the feedback from previous students and teaching assistants of CS0/CS1, telling us that students have a hard time to see the relationship between what they are learning in CS0/CS1 and "the real world." The people talking on the videos are all from real life and convey experiences that are contrary to common stereotypes. The impact of multimedia in our experiment is to let students see real computer scientists and hear what their work is really like. Then an interactive exercises helps them reflect on what they have observed

CONCLUSIONS AND FURTHER WORK

This study looked at the immediate influence of the multimedia. We plan to re-administer the posttest to the same students at the end of the semester, to determine whether there is a long-term effect, in the context of the entire course, using *The Universal Computer: A Multimedia Introduction to Computer Science* [2].

Our results strongly support these hypotheses: 1) students taking a first semester course in computer science still have many negative stereotypes about the field and 2) effective multimedia can help overcome misconceptions. We also found that it is more common for female students to have misconceptions such as "Computer scientists work alone at their computers" and multimedia has more power to help female students to overcome them. Further investigation is needed to determine whether these results persist and whether similar effects may be found in other populations, including students in middle or high schools, where the pipeline is more critical [5]. We are adapting the misconceptions multimedia for use even earlier in the pipeline (middle school students) and will conduct a similar experiment.

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