A CS1 Course Designed to Address Interests of Women

Lauren Rich
College of Computing/GVU
Georgia Institute of Technology
801 Atlantic Drive
Atlanta, Georgia
lain@cc.gatech.edu

Heather Perry
College of Computing/GVU
Georgia Institute of Technology
801 Atlantic Drive
Atlanta, Georgia
hperry@cc.gatech.edu

Mark Guzdial
College of Computing/GVU
Georgia Institute of Technology
801 Atlantic Drive
Atlanta, Georgia
guzdial@cc.gatech.edu

ABSTRACT

Literature on women in computing points out that computer science is not being effective at attracting and retaining women. *Introduction to Media Computation* is a new CS1 aimed especially at non-majors which was designed explicitly to address the concerns of women in computer science, such as the lack of relevance and creativity. The course is contextualized around the theme of manipulating and creating media. Of the 121 students who took the course (2/3 female), only three students dropped (all male), and 89% completed the course with a grade C or better. This paper presents data from interviews with women in the Media Computation class, then contrasts with interviews in a more traditional CS1.

Categories and Subject Descriptors

K.4 [**Computers and Education**]: Computer and Information Sciences Education
; H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems

General Terms

Experimentation,Design

Keywords

Multimedia, CS1/2, programming, non-majors

1. INTRODUCTION

Computer science programs are not successfully attracting and retaining women, which is reflected by the gender gap in computing [8]. Studies suggest that women are discouraged from the field by the stereotype of computer science as boring and asocial, the irrelevance of material to non-majors, and an intimidating, uninviting culture [1, 8].

SIGCSE'04, March 3–7, 2004, Norfolk, Virginia, USA.

We designed a new CS1 course, CS1315 *Introduction to Media Computation*, that specifically addresses these issues. Our approach is to offer an *alternative path* into computer science as suggested in some of the recent studies of the problem [8]. During its Spring 2003 pilot offering, we evaluated the effects of this approach on female students. This paper describes the attitudes of women in the course and compares these attitudes with females in a traditional CS1 on the same issues. We discuss the design of the course and assessment results in the context of research issues for women in computing. Then, we examine the attitudes of women in the course and contrast with females in a traditional CS1.

Georgia Institute of Technology (*Georgia Tech*) requires all students to take an introductory computer science course that includes programming. The traditional CS1 course at Georgia Tech, CS1321 *Introduction to Computing,* is quite unpopular among those students not in computing fields. CS1321 has a reputation on campus for being extremely difficult, time consuming, and irrelevant to most majors. CS1315 provides an alternative course for non-CS and non-Engineering majors to fulfill the CS1 requirement.

2. DESIGN GOALS FOR THE MEDIA COMPUTATION CLASS

CS 1315 *Introduction to Media Computation* was designed to appeal to women by addressing the concerns revealed in the aforementioned studies of gender issues in computing. To combat these issues, the course design incorporated the following elements:

- Creativity: to counter the reputation of CS as boring.
- Relevance: to illustrate that CS concepts are applicable to non-majors.
- Collaboration: to counteract the stereotypes of computing as asocial and inhospitable.
- Restricted registration: to reduce intimidation and support a hospitable culture.

We describe the approach of the Media Computation class as *data-first*: It starts with data of interest to students (images, sounds, HTML pages), and introduces computing as a useful lever for manipulating these data. The data-first, multimedia approach provided real applications of technology and allowed for creative freedom. Course assignments allowed students to manipulate their own media—sounds,

pictures, etc.—with the code they wrote. Assignment requirements were often open-ended, allowing the student to delve as far into the assignment as he or she wanted. For example, one homework assignment asked students to write code to create a collage consisting of one or more images with at least four manipulations applied from a series that included color alteration, scaling, cropping, negating, lightening, and darkening.

We designed the course to meet the *imperative first* CS1 approach [2], covering much the same content as the standard "CS101I. Programming Fundamentals" course. In general, our approach is to contextualize the programming so that it is relevant and motivating, and then introduce more abstract concepts, in keeping with learning sciences findings on how to achieve transferable learning [7]. The first nine weeks of the course focus on using programming to achieve media effects, in pictures, sounds, and text. We introduce simple network and database programming as a source for text to manipulate. Simple data structures are used such as arrays (e.g., sounds are arrays of samples, strings are arrays of characters), matrices (pictures are matrices of pixel objects, each with red, green, and blue components), and trees (e.g., when walking a directory to gather frames for a movie). Primitive types are introduced to explain why the red component of a pixel can only have values 0–255 and why samples are in the range of +/- 32K. Issues of design and debugging are mentioned as they make sense, but aren't the focus until the end of the class. In the last weeks of the class, we introduce more traditional computer science as an answer to their questions.

- During the course, many students noted that their programs were consistently slower than applications like Adobe Photoshop that performed the same functions. Why? To answer this question we introduced CS concepts such as machine language, interpreters, and compilers; and algorithmic complexity.
- Students often asked if there was an easier way to write these programs—could they be done with fewer lines or more easily? We introduced functional programming and recursion as techniques for writing smaller programs, and object-oriented programming as a mechanism for writing larger programs more easily.

To combat the asocial reputation of computing and to support a more hospitable environment, collaboration was woven into aspects of the course. Students were encouraged to collaborate on homework assignments with the stipulation that they must note the others with whom they worked. Study groups were encouraged as well. Further, the CoWeb collaboration tool was used to support a collaborative experience in course [5]. The CS1315 CoWeb[1] provides a place for students to post questions on assignments, discuss solutions to exam review questions, comment on the course, and conduct discussions on current events or other non-course related topics. Students could post anonymously to remove any anxiety or pressure when asking questions.Students were encouraged to share the products of their work on the homework gallery located on the course CoWeb, thus introducing a social aspect to the creative assignment.

The course sought to create a more hospitable culture for learning computer science, as registration was restricted to students in the following colleges: Ivan Allen (Georgia Tech's liberal arts college), Architecture, Management, and Sciences. No computer science or engineering majors were allowed to register for the course. The goal of these restrictions was to facilitate a comfortable environment for students not inclined to computing.

[1] `http://coweb.cc.gatech.edu/cs1315`

3. EVALUATION OF THE CLASS: WAS IT SUCCESSFUL?

In Spring 2003, CS1315 *Introduction to Media Computation* was offered for the first time to a pilot class of 120 students. Since Georgia Tech is 28% female, we were surprised to find that our course ended up being 2/3 female. CS1315 had a better retention rate than we typically see in CS1. Georgia Tech's traditional CS1 has an average 27.8% WFD (withdrawal, failure, or D) rate. In Media Computation, only three students withdrew from the course (all of whom were male). 89% of the students who enrolled earned an A, B, or C, for a WFD rate of 11.5%. We compared the pilot media computation class to a section of our traditional CS1, and a section of a new Engineering-specific CS1. During the same semester, the section of the traditional CS course that we studied had a 43% WFD rate, and the Engineering course had a 19% WFD rate.

Overall, the students programmed, and programmed successfully. Students wrote eight programs in the class: Six collaboratively, two on their own as *take home exams*. On the collage assignment, some student programs exceeded 100 lines of code. The final assignment was to write a program to fetch the page at `http://www.cnn.com`, parse out the top three headlines, then create a ticker-tape movie of the headlines moving across the screen.

Besides the interviews described later in this paper, we also conducted surveys of the students at the start of class, at midterm, and at the end of class. These surveys helped us to get an overall sense of whether the class was meeting its design goals. The issue of relevance came through very clearly on the midterm survey. When we ask students "What is something interesting, surprising, or useful that you learned?" we found that students were buying into the relevance of the course and even finding the computer science interesting (all female respondents):

- "The most useful things I have learned are the basics about computers and pictures/sound."
- "Just general concepts about programming. It's pretty logical, sort of like in math, so it's understandable."
- "Programming is fun and ANYONE can do it!"

Students saw the class as being relevant and useful. At midterm time, we asked student in all three CS1 courses what they liked in the class. Table 1 summarizes the results, coded from the students' essay responses [4]. Students in both the media computation and Engineering CS1 recognized the value of the content, in contrast to the traditional CS1.

Furthermore, CS1315 seemed to increase the students interest in more computing courses. The final survey included two questions about taking more computer science, one that asked if students wanted to take more computer science classes and the other asking explicitly about a second, advanced media computation course. Whereas less than 10%

of CS1315 females expressed a desire to continue with more computer science courses, more than 60% said that they'd be interested in taking an advanced media computation course. The same trend applies to the class as a whole—63% of the class overall said that they would be interested in taking a second course. Why the seeming contradiction between "no more computer science, but I'll take another media computation course" is something we're exploring now.

Course	Don't like it/Nothing	Enjoy Content	Content is Useful
Trad. CS1	18.2%	12.1%	0.0%
Engineering	12.9%	16.1%	25.8%
Media Comp	0.0%	21.3%	12.4%

Table 1: What students like about the course at the midterm survey, comparing traditional CS1 section, a section of Engineering-specific CS1, and the media computation course

4. EFFECT OF MEDIA COMPUTATION ON FEMALE ATTITUDES

4.1 Interview Format

Lauren Rich conducted interviews with females in the CS1315 Spring 2003 pilot to determine if the course successfully addressed gender concerns and interested females in computing. Participants were unpaid volunteers who were invited to participate through a posting on the class CoWeb and a personal request in class by Lauren. The interviews lasted from thirty minutes to an hour and consisted of a series of open-ended questions about attitudes and experiences with computer science. Some questions concerned the learning objectives of the course, while others addressed the relative success of the course in addressing gender issues. Further questions involved general opinions toward computer science.

The interview questions were designed to determine whether the course successfully addressed the items listed in Section 2 (creativity, collaboration, relevance). Because the questions were open-ended, the responses show whether the issues were successfully addressed and provide a measure of that success. Overall, the questions sought to determine the course's effects on female attitudes towards computer science.

4.2 Interview Results

Seven interviews took place total, with three at midterm and four during finals. Three of the females were interviewed during both sessions, and one additional female was interviewed during the second round. All interviewees were in their first, second, or third year of college and their majors included International Affairs and Modern Languages, Public Policy, and History, Science, and Technology. All had a home computer when growing up and considered themselves computer literate.

The interviews gave us evidence that suggested we had succeeded at our design goal of creating a CS1 in which students found programming interesting and even fun: A creative CS1.

> Q: What is the most surprising, or interesting thing you've learned?
>
> Student 3: That it's fun. I know that's not specific.
>
> Q: "It" being CS, or programming, or what?
>
> Student 3: Both. The history of the computer and the Web. And that programming is not scary, it is actually pretty cool and when you make a program that actually runs it's a really good feeling. I didn't expect to enjoy it at all because all I'd heard were just the bad stories...

We asked directly about intimidation to assess the effect of restricting registration on female attitudes and course culture. Those interviewed said that they felt at ease asking questions, which may support the course restriction preventing CS and Engineering from taking the course. These students suggested that having CS majors in the course would raise their anxiety significantly

> Q: Did you ever feel intimidated by anyone in the class?
>
> Student 3: Nope. I think it's really good that we don't have a lot of CS majors in the class. Because if we did, I would feel very intimidated because I wouldn't know everything that they know.

Collaboration stands out as an important factor in student success and enjoyment of the class. When asked on the final survey what must not change about the course, nearly 20% of students specified the CoWeb, and over 20% referred to collaboration in general. One interviewee's response illustrates the role it played in her experience:

> Q. What about collaboration?
>
> Student 3: Actually, I think that is one of the best things about this class. My roommate and I abided by all the rules... , and we didn't collaborate on anything we weren't supposed to even though we live like 5 feet away from each other. ... I don't think that this class would have been as much fun if I wasn't able to collaborate.

To determine the effect of collaboration on the perception of computing as asocial, we asked several questions related to collaborative elements in the course. All of the females interviewed made use of the CoWeb, both to read other students' questions and to post their own. When asked about her use of the CoWeb, one student added that the demographics of the course contributed to her comfort level, making it easier for her to get assistance when needed:

> Q: Have you ever posted to the CoWeb?
>
> Student 1: I think I've posted to everything. Sometimes I ask a specific question and he [the professor] asks for clarification. I would feel different in a class with a bunch of CS majors. But since we are there with a bunch of management, other students, it's kind of more comfortable.

For this student, the collaborative environment depended heavily on the culture of the course. Another student cited the ability to post anonymously as making the CoWeb a more comfortable discussion space:

Q: Do you think the CoWeb is beneficial? Why?

Student 4: Yes. And there's no reason to feel uncomfortable because if you feel dumb, just don't put your name at the end! I did that a few times.

Specific activities in the class CoWeb became focuses of attention. One was an open discussion space called the *Soapbox* for exchanging non-course related ideas, and several interesting conversations took place on this page. The CoWeb also supplemented creative aspects of the course, as students were encouraged to share the results of their homework in galleries.

Q: What do you think about the homework galleries on the CoWeb?

Student 4: It's nice to see other people, like what they did with it... And there is no better feeling than getting something done and knowing that you've done it right. Like the soapbox sometimes is just like "I did it!" and posting to the CoWeb just adds onto that.

Student 3: I don't ever look at it [the homework gallery] until after I'm done. I have a thing about not wanting to copy someone else's ideas. I just wish I had more time to play around with that and make neat effects. But JES [Jython Environment for Students—the programming environment created for this class [6])] will be on my computer forever, so... the nice thing about this class is that you could go as deep into the homework as you wanted. So, I'd turn it [the homework assignment] in, and then me and my roommate would do more after to see what we could do with it.

That last quote also highlights one of themes in the interviews that suggested how the students found this relevant: That the student planned to leave "JES... on my computer forever." Students told us stories both in interviews and in the surveys about writing programs for their own purposes, sometimes, just for fun. Students spoke about manipulating their own pictures, and even playing songs backwards to listen for hidden messages. Writing programs outside of course contexts, for their own purposes, suggests a level of relevance beyond some future use in a profession, but as everyday, computing literacy [9].

The CoWeb wasn't the only way that students collaborated. All of the interviewees participated in study groups for learning the material, working through homework assignments, and preparing for exams. One student described how she and her roommate would go home after class and try out examples from the lecture, tweaking code to see what it would do. Other interviewees claimed to do similar modifications to code simply out of interest and curiosity. Thus, the course material and assignments successfully engaged females and interested them in programming.

Interview participants were proud of their accomplishments and claimed that their experiences caused them to feel more confident. Females were generally surprised at their own ability and enjoyment of computer science, as revealed during the interviews when they were asked what was the most interesting or surprising thing they learned:

Q: What's the most surprising/interested thing you've learned?

Student 4: That it's fun. And programming is not scary. It is actually pretty cool, and when you make a program that actually runs, it's a really good feeling. I didn't expect to enjoy it because all I'd heard were just the bad stories.

5. STUDY OF FEMALES IN TRADITIONAL COMPUTER SCIENCE

In Summer 2003, Heather Perry conducted a comparison study with females in our traditional CS1321 *Introduction to Computation*. Participants were unpaid volunteers who responded to an on-line advertisement and an in-class request. Georgia Tech's traditional CS1 *CS1321* uses the *TeachScheme* approach [3]. The interview guide for this study of a traditional CS1 used an adaptation of the Media Computation interview guide in order to address the same gender issues. Questions specific to the Media Computation course were modified to correspond to similar topics in our traditional CS1, and some additional topics were addressed as well. Seven interviews with four women were conducted in two rounds of interviews, at midterm and the end of the semester. All four females participated in the initial interviews, and three returned for the final round. These interviewees included Materials, Industrial, and Civil Engineering, as well as Biology/Pre-med majors.

Before discussing the interview results, it's important to note the similarities and differences between females in the traditional CS1 (CS1321) and those in the Media Computation class (CS1315). In our surveys and interviews, both groups expressed fear of computer science courses and felt they had basic computer skills before taking their respective courses. When asked what computer literacy means, a female in CS1321 said "I can generally play around and find my way around a computer or a new program." The females in CS1321 took the class during a condensed 12-week semester whereas the CS1315 class was offered during a normal 16-week semester. Further, the females interviewed in CS1315 were mostly liberal arts students, whereas the CS1321 interviewees chose Engineering and Science majors. These fields of study differ greatly in gender composition, so it's worthwhile to note that the experience of these women cannot be adequately compared.

Interview responses indicate that women in CS1321 experienced the issues that gender studies attribute to female disinterest in computing, including irrelevance of material and intimidation [1, 8]. Results of these interviews show that CS1321 did not drive these females away, and none of the participants disliked the course.

However, all of the interviewees expressed dissatisfaction with the relevance of the course material to their field. They acknowledged that the course was interesting but found the material inapplicable to their chosen majors and future careers. Their comments also suggest that they found some truth in their previously held stereotypes about the asocial nature of computer science.

Q: Is CS fun?

Student 1: Yeah, it's just interesting that you can... Like I never thought that I would enjoy sitting here at 11 at night doing Scheme programs

but you get to see people and you bond, and we order pizza. It's better than constantly working with numbers and math, physics...

Student 3: Well, I wouldn't do it on the weekends. It's like doing a crossword puzzle or something, so it's good for a class.

Q: Is CS useful to you?

Student 1: I don't know yet. Some of the examples that we've done you can see how you can apply the concepts to real life. Like there was an example with seeing how when you make a deposit in the bank it finds the balance, you can see how that's related to real life, but I don't know if you can do that with Scheme

Q: Is CS relevant to your career and/or personal life?

Student 3: Maybe, I'm not sure yet. I don't know about my personal life, but I guess if I want to be a doctor later, yeah, the skills I learned will be important, like logical thinking.

Student 1: I still don't know about how it will apply to my career. Personal? Right. Like, I just got back from lunch with (my friend), and he suggested that we could decide where to go to eat by making up lists of restaurants. Right. (Laughs)

While CS1321 does permit collaboration on all homework assignments, none of the females took advantage of the opportunity to work with others, nor did they make use of study groups for exam preparation. Responses to questions specific to the course reflect its technical approach (much as described [1, 8]), as the interviewees consistently described data structures when discussing course topics.

These females experienced some intimidation in the course, especially from males who asked questions in class and seemed to know significantly more computer science than them. One female in CS1321 said, "I think a lot of the class are intimidated by those little groups who sit together". In general, the interviewees appreciated the course as a different way of thinking, but they were not particularly engaged or excited about the material. None indicated a desire to learn more about computing or take more computer science, as one CS1321 interviewee said, "I guess if I had to take it, I really wouldn't mind, but I don't have to."

6. SUMMARY

Women are an underrepresented minority in computer science, as CS programs struggle to attract and retain female interest in computing [8]. Studies attribute female disinterest and discouragement to stereotypes of CS as uncreative, asocial, inapplicable, unfriendly, and intimidating [1, 8].

The design of CS1315 *Introduction to Media Computation* directly addressed these issues, and our evidence suggests that we were successful at engaging females in CS. The traditional introductory computer science course at Georgia Tech, CS1321 *Introduction to Computation*, did not explicitly drive females away from computing, but it exemplified some of the characteristics that tend to make computing less appealing to females. Overall, females in Media Computation expressed greater enjoyment and interest with the course than those interviewed in the traditional CS1.

There is much more that we would like to learn about this approach. In general, we do not know whether students learned similar things in our different CS1's because of the challenges of trying to measure learning in different kinds of classes with different languages, orderings of topics, and emphases [4]. We are trying now to explore students attitudes in order to understand their perception of what computer science is and how the media computation approach influences that perception. Finally, we are interested in studying the long-term effect of the course. Do students take more computer science courses? Even if they don't, does the course influence their attitudes and abilities with respect to using technology?

7. ACKNOWLEDGMENTS

This research is supported in part by grants from the National Science Foundation (CISE EI program and DUE CCLI program), from the Al West Fund at Georgia Tech, and by the College of Computing and GVU Center. We wish to thank all the students who helped create JES and the Media Computation class, and all the students in the class who volunteered to participate in our studies.

8. REFERENCES

[1] AAUW. *Tech-Savvy: Educating Girls in the New Computer Age*. American Association of University Women Education Foundation, New York, 2000.

[2] ACM/IEEE. Computing Curriculum 2001. *http://www.acm.org/sigcse/cc2001*, 2001.

[3] M. Felleisen, R. B. Findler, M. Flatt, and S. Krishnamurthi. *How to Design Programs: An Introduction to Programming and Computing*. MIT Press, Cambridge, MA, 2001.

[4] A. Forte and M. Guzdial. *Computers for Communication, not Calculation: Media as a Motivation and Context for Learning*, Hawaii International Conference on System Sciences, To appear. 2004.

[5] M. Guzdial. Use of collaborative multimedia in computer science classes. In *Proceedings of the 2001 Integrating Technology into Computer Science Education Conference*. ACM, Canterbury, UK, 2001.

[6] M. Guzdial. A media computation course for non-majors. In *Proceedings of the Innovation and Technology in Computer Science Education (ITiCSE) 2003 Conference*, pages 104–108, New York, 2003. ACM.

[7] J. Kolodner. *Case Based Reasoning*. Morgan Kaufmann Publishers, San Mateo, CA, 1993.

[8] J. Margolis and A. Fisher. *Unlocking the Clubhouse: Women in Computing*. MIT Press, Cambridge, MA, 2002.

[9] E. Soloway, M. Guzdial, and K. E. Hay. Reading and writing in the 21st century. *EDUCOM Review*, 28(1):26–28, 1993.