Constructing Media as a Context for Teaching Computing and Motivating Women and Non-Majors

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Abstract

To address the high rates of failure among women and non-majors in introductory computer science classes, we developed a CS1 course centered around media and communications. Introduction to Media Computation introduces programming and computing ideas through students programming image filters, splicing and reversing sounds, implementing digital video special effects, building Web searching tools, and writing programs that generate text. We support the course with a textbook (available now through Pearson), a programming environment (for Python), and a collaborative website on which students can share their media creations. In the two semesters that the course has been offered, over 400 students have taken the course, 2/3 of whom were female, with an average WDF (withdrawal, or earned D or F) rate of 12%. Students report that they find the course relevant and creative, with a rich social context. The course and components of it are currently being tested in two and four year schools outside of Georgia Tech. The success of the course is leading us to develop a second course, a CS minor, a pathway into the CS major through media computation, and a new *BS in Computational Media*.

1 Creating a Computing Course that Retains Students

The problem being addressed by this project is the disinterest in computer science exhibited by large groups of students, especially non-CS-majors and women—a particular problem at institutions like Georgia Tech where an introductory computing course is required.

- Percentages of women and minorities are dropping in Computer Science.
- Applications to Computer Science undergraduate programs are down across the country, partly in response to the perception that "all programming jobs are going overseas."
- Withdrawal-or-failure (withdrawal from the course, or earning a D or F) rates in introductory computing courses nationally are in the range of 30–50%.

Based on research literature on why students fail in computer science (e.g., Margolis & Fisher, 2001; American Association of University Women, 2000), we defined three goals for a new kind of computing course: That it be perceived as *relevant*, that it offer opportunities for *creativity*, and that it create a *positive social context*.

Our course *Introduction to Media Computation* is aimed at non-CS-majors. The course is now a requirement for all students in Georgia Tech's College of Architecture, College of Management, and Ivan Allen College of Liberal Arts.

Our argument is that these audiences are most interested in computing to manipulate data of interest to them. We developed a "*data-first*" approach where we introduce computing in terms of creation, manipulation, and transformation of data of interest to students. The base premises for the course are:(a) All media are moving to a digital format; (b) digital media are manipulated using software; (c) learning to control computation, including programming, then becomes a communications skill.

2 Course Curriculum

2.1 Example Programs

We teach Python (`http://www.python.org`, specifically the Java-based variant *Jython* `http://www.jython.org`).

```
def clearRed(picture):
 for pixel in getPixels(picture):
  setRed(pixel,0)

def grayScale(picture):
 for p in getPixels(picture):
  intensity = (getRed(p)+getGreen(p)+getBlue(p))/3
  setColor(p,makeColor(intensity,intensity,intensity))
```

Figure 1 Programs to clear all the red from pixels in a picture and to convert an input picture to grayscale.

2.2 Syllabus

Our syllabus is based on an observation from the learning sciences that students can't learn abstractions on experience until they have concrete experiences. These students have little to no previous programming experience. Our goal in the first 2/3 of the course is to motivate them to develop concrete programming experience.

- Pictures as a media type, including psychophysics (why don't we see 1024x768 dots on the screen?), looping to change colors, conditionals to replace specific colors, then indexing by index numbers to implement mirroring, rotating, cropping, and scaling.
- Sound as a media type, including psychophysics (how human hearing limitations make MP3 compression possible), looping to manipulate volume, then indexing by index numbers to do splicing and reversing of sounds.
- Text as a media type: Searching for text, composing text, reading text from a file and writing it to a file.
- Shifting media representations, e.g., creating visualizations of sound.
- Movies: How persistence of vision makes animations and movies possible, generating frames using the various techniques described earlier in the semester, manipulating whole directories of files.

Assignments are often open-ended. For example, we ask students in the third week to build a collage where images appear multiple times with some image manipulation, but students can choose their images and the manipulations (Figure 2). Similarly, we ask students to build audio collages and movies. Students are invited to post their created media in a shared *CoWeb* (Collaborative Website) for all to see (`http://coweb.cc.gatech.edu/cs1315`).

Students then have real questions that Computer Science can help them answer.

- "Can't we do this any faster? Why is Photoshop faster than Python?" Introduction to how a computer works (e.g., machine language), and the difference between an interpreter and a compiler. Algorithmic complexity and the limits of computation.
- "Can we do this any easier?" Decomposing functions, modularity, and functional programming (map, reduce, filter, and simple recursion). Introduction to objects and classes.
- "What do other programming languages look like?" Brief overview of JavaScript and Squeak.

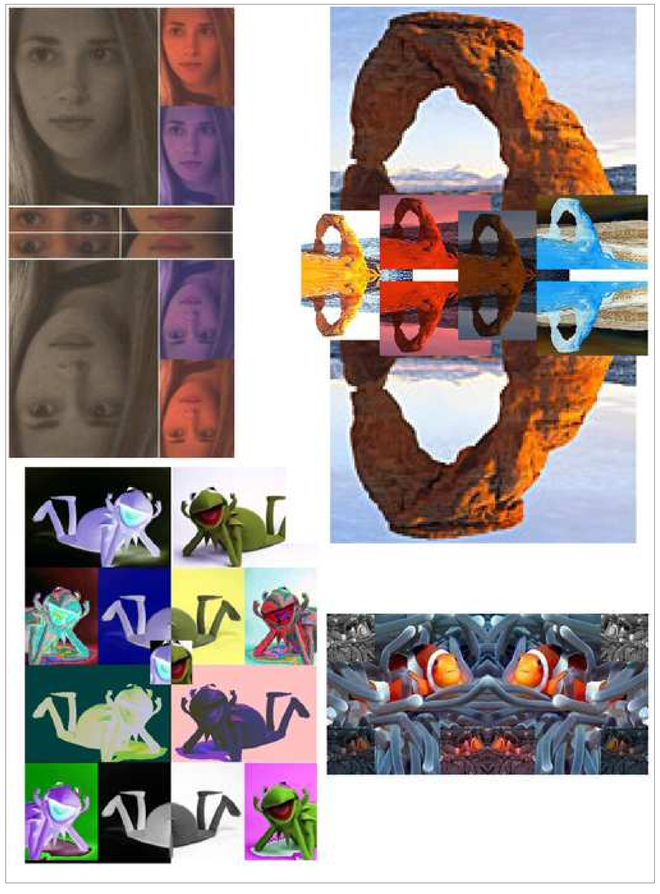

Figure 2 Examples of collages produced by *Introduction to Media Computation* students

3 Data Sources and Methods

- We checked demographic data, such as WDF rates between our traditional introductory computing course and the new MediaComp course.
- We surveyed students at the beginning, midterm, and end of the terms, then coded the results with high inter-rater reliability.
- We interviewed females, as one target population for our efforts.

4 Results

Our traditional introductory computing (CS1) class, over a three year period (with all majors taking it) had a 27.8% WFD rate. The Spring 2003 pilot of *Introduction to Media Computation* had 121 students, 2/3 female, with no Computing or Engineering students, had a 11.5% WDF rate. Our Fall course had 303 students, just over half male. We currently have 395 students in the course.

	WFD Rate
Average Traditional CS1 (2000-2002)	27.8%
Traditional CS1 Sp03	37.5%
MediaComp Sp03	11.5%
Traditional CS1 Fall03	18.54%
MediaComp Fall 03	12.5%

Figure 3 WDF Rates for first two terms of Media Computation class and traditional CS1

When asked what they like about the class in the midterm survey, the students affirmed that we're succeeding at creating a course that students recognize for its relevance, particularly for non-CS majors:

> "Very applicable to everyday life."
>
> "I dreaded CS, but ALL of the topics thus far have been applicable to my future career (and personal) plans."
>
> "The professor answers questions in class and online and is concerned about our success in the class. He also seems to understand that most of us are not engineers and most likely won't do straight programming in the future—just the way of thinking is important."
>
> "I think that we're doing things that I could actually use as an architecture major–I like dealing with pictures and sounds."

Students even reported programming on their own in interviews.

> "I just wish I had more time to play around with that and make neat effects. But JES (programming environment) will be on my computer forever, so thats the nice thing about this class is that you could go as deep into the homework as you wanted. So, Id turn it in and then me and my roommate would do more after to see what we could do with it."

5 Next Steps

- The course has been adopted by several schools, in entirety (e.g., Gainesville College) or parts (e.g., Brandeis University, University of Maryland at College Park, DePauw University).
- Some of our students have become CS majors. In response to their interest in more Computing, we have defined a second media computation course, *Representations of Structure and Behavior*, which will cover data structures content. The two courses will form a pathway into our CS major or our newly defined CS minor. With our *New Media Center* in the School of Literature, Communications, and Culture, we are defining a *BS in Computational Media*.
- We have been asked by the Georgia Department of Education to use our media computation approach to teach high school teachers how to program so as to increase the number of certified computing and CS AP teachers in the state. We are adapting our materials to Java for this purpose.

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