Computing for Everyone: Introduction to Computing via a Media-Context for Non-CS Majors

Mark Guzdial
College of Computing/GVU
Georgia Institute of Technology

College of Computing/GVU
Georgia Institute of Technology
801 Atlantic Drive
Atlanta, GA 30332-0280
email: guzdial@cc.gatech.edu
http://www.cc.gatech.edu/~mark.guzdial
http://coweb.cc.gatech.edu/mediaComp-plan

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 Prentice-Hall), a programming environment (for Python), and a collaborative website on which students can share their media creations.

In the two years that the course has been offered, the attrition rate has dropped dramatically. 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 has lead us to develop a follow-on 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.

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.

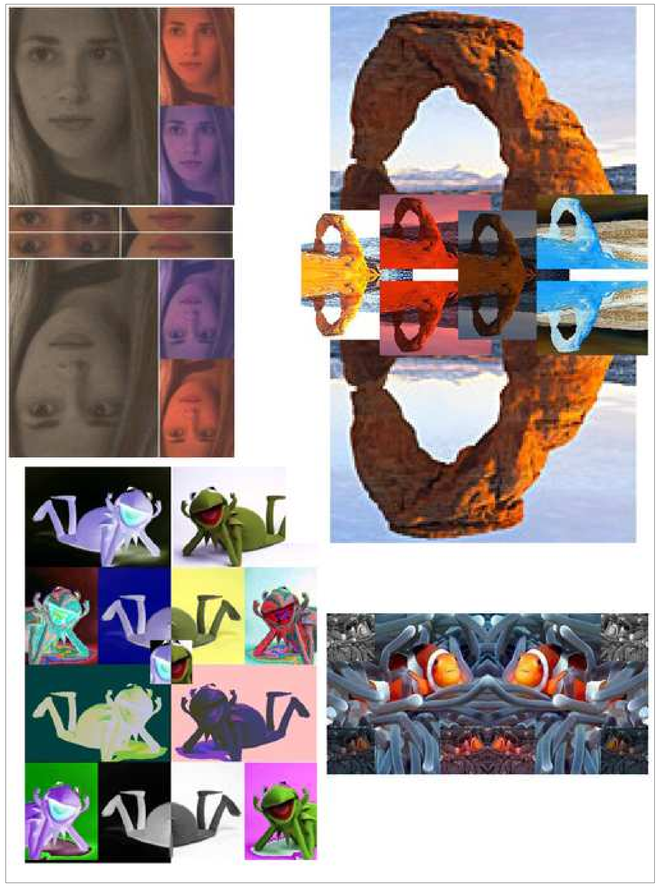

Figure 2 Examples of collages produced by *Introduction to Media Computation* students

3 Results

Our new course has been majority female (53%) and has had success rates (students earning an A, B, or C) up to 90%.

	Success Rate
Average Traditional CS1 (ave 2000-2002)	71.28%
Media Computation (ave Sp2003-F2004)	83.3%

Figure 3 Success rates of traditional CS1 vs. Media Computation CS1

The course has now been adopted at other institutions, including University of Illinois-Chicago and Gainesville College in Northern Georgia. Gainesville has had similar improvements in success rates

	Success Rate
Gainesville CSCI 1100 (ave 2000-2003)	70.2%
Media Computation (ave Sum2003-Sum2004)	82.4%

Figure 4 Success rates at Gainesville College before and after starting Media Computation

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."
>
> "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."

4 Follow-on Survey

In Spring 2004, we conducted an email survey of students who took the course in Spring 2003 and Fall 2004.

- 19% of respondents had written a Python program on their own since the class had ended.
- 27% had edited media that they hadn't previously.

> "Definitely makes me think of what is going on behind the scenes of such programs like Photoshop and Illustrator."
>
> "I feel more comfortable around computers and like I could learn and understand other computer programming languages more easily."

5 Next Steps

- The text for the media computation class is now published by Prentice-Hall as *Introduction to Computing and Programming: A Multimedia Approach*.
- 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 first offering is Spring 2005, with 32 students, 75% of whom are female.
- The two courses 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 have defined a *BS in Computational Media*. In the first semester of the new degree (Fall 2004), 36 students declared the new major.
- 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. The text will be published by Prentice-Hall in December 2005.

Funded in part by a National Science Foundation CCLI "Proof of Concept" grant, CISE Educational Innovations grant, GVU Center and College of Computing, and the Al West Fund at Georgia Tech. Software developed by teams of (mostly undergraduate) students.