Contextualized Computing Education
## *Increasing Retention by Making Computing Relevant*

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Across America and Europe, enrollment and retention in computing courses and degree programs is plummeting. Several studies have found that one of the problems is the traditional computing curricula. Students find computing in these courses to be highly abstract and lacking relevance [1, 2], overly concerned with tedious details, and lacking opportunities for creativity [3].

Our approach at Georgia Tech is to emphasize **context**. Computing is broadly applicable to a wide variety of disciplines and domains—these are *contexts*. We use programming languages, lectures examples, and programming assignments from those contexts that students recognize as being authentic and relevant for computing.

Engineering: From Fall 1999 to Spring 2003, every student at Georgia Tech in every discipline was required to take an introductory course in computing, but we offered only the course that we created for our own majors. During that time, almost 30% of the students failed or withdrew from the course. In Spring 2003, we introduced an introductory course contextualized in engineering [4]. The class and all assignments are in MATLAB, the *lingua franca* of engineering programming. Lecture examples are drawn from engineering problems, and students use MATLAB to solve engineering-related problems. Retention has risen dramatically, and students report that they program in MATLAB outside of class because they find it so useful [5, 6].

Media Computation: In Spring 2003, we also introduced a course in computing for the Architecture, Management, and Liberal Arts majors. The context for this course is the creation and manipulation of digital media. Student learn iteration by computing negative and grayscale images; iteration in a range by removing red-eye *just* around the eyes; array concatenation by splicing sounds; and string processing by downloading and parsing Web pages to extract content and then generating videos with that content [7, 8]. Student assignments involve the creation of audio and video collages (such as the images to the right) and movies using the students' own content, which makes them motivating and personally relevant [5]. Retention rose dramatically, with some students even becoming computing majors or minors [9]. In a follow-up survey a year after the course started, students told us how the course had changed how they thought about and used computing, with 20% of the respondents told us that they were programming on their own since the class had ended [10]. We have since used Media Computation with high school teachers [11] and high school students with similar success. Other schools are
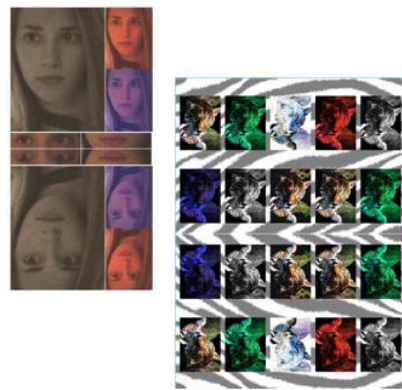
now adopting Media Computation approaches and finding similar improvements in retention with their students [12, 13]. We have started a Media Computation data structures class, which now has a success rate over 90%.

Robotics: We are just beginning the process of developing the introductory courses for our CS majors using a robotics context. We plan to teach the basics of programming (``CS1'') and more advanced data structures (``CS2'') through programming robots. Robots are an authentic context for computing—students know that computer scientists work with robots, and that robots are useful and relevant. Robots offer us the opportunity to make computing tangible—students can watch the robots move and can even interact with them, to literally ``see'' their computation in action.
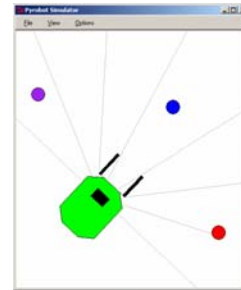
Culturally Contextualized Computing Education: So far, our work in contextualized computing education has dealt only with Americans, and mostly middle class Americans at that. We are interested in exploring what kinds of contexts might be relevant for *other* cultural contexts. Middle class Americans recognize that computing is relevant in the contexts of engineering, digital media, and robotics. In what contexts do other cultural groups find computing relevant and authentic?

We are starting to explore that question in collaboration with the University of Texas at El Paso where they are adapting our media computation course with their predominantly Hispanic population. We hope to learn if their students find media computation a context in which to express their own cultural values, not just the cultural values traditionally associated with computing. We are interested in exploring the definition of computing education contexts that are relevant for other, more diverse cultures.

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