Final Report for Period: 08/2006 - 07/2007
Submitted on: 11/08/2007
Principal Investigator: Guzdial, Mark .
Award ID: 0306050
Organization: GA Tech Res Corp - GIT
Title:
Introduction to Media Computation: A New CS1 Approach Aimed at Non-Majors and Under-Represented Populations

Project Participants

Senior Personnel

Name: Guzdial, Mark
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Rick, Jochen
Worked for more than 160 Hours: Yes
Contribution to Project:
studying use of collaboration in course

Name: Fithian, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:
studying use of technology in course

Name: Forte, Andrea
Worked for more than 160 Hours: Yes
Contribution to Project:
studying attitudes and retention rates in course

Name: Wilson, Adam
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Tew, Allison
Worked for more than 160 Hours: Yes
Contribution to Project:
Evaluation of student learning and attitudes

Undergraduate Student

Name: Rich, Lauren
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Perry, Heather
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Yeager, Joe

Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Augur, Wes
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Barber, Justin
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Connelly, Ryan
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Carnahan, Patrick
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Poncz, Adam
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Giles, Aron
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Rawlins, Noah
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of student software (JES)

Name: Lyons, Kelly
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of teacher support materials

Name: O'Hare, Blake
Worked for more than 160 Hours: Yes
Contribution to Project:
Development of teacher support materials

Name: Olson, Larry
Worked for more than 160 Hours: Yes
Contribution to Project:
Conducted an analysis of transfer learning in CS1 courses.

Name: Baker, Dannon
Worked for more than 160 Hours: Yes
Contribution to Project:

Conducted an analysis of transfer learning in CS1 courses.

Technician, Programmer

Other Participant

Name: Ericson, Barbara

Worked for more than 160 Hours: Yes

Contribution to Project:

Development of Java version of curriculum and materials

Research Experience for Undergraduates

Organizational Partners

Georgia Department of Education

We are now working with the Georgia Department of Education on workshops to help teachers learn to teach programming and Computer Science AP courses

Gainesville College

University of Illinois at Chicago

Australian National University

University of Texas at El Paso

South Carolina State University

Other Collaborators or Contacts

2005:

We are starting a collaboration with the University System of Georgia to develop workshops on our approach for undergraduate faculty from across the state.

2004:

We continue to work with Charles Fowler at Gainesville College, <http://www.usg.edu/inst/gainesville.html> a public two year school in northern Georgia, which has already started offering sections of the course. We have started working with Kennesaw State University, DePauw University, Brandieis University, University of Maryland at College Park, and University of Illinois at Chicago as they begin to adopt all or part of our media computation approach.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

During the last year 2005:

*The course, Introduction to Media Computation, continues to be offered, but now always by faculty and instructors other than the PI. The course continues to engender an 80-85% success rate (completing the course with an A, B, or C), compared to mid-70% for our traditional CS1.

Women continue to be the majority gender of the course, and to do as well or better (in earned GPA and in retention) than men each term.

*The follow-on course, Representing Structure and Behavior, was taught for the first time in Spring 2005. This is a data structures course, that continues in the media context for relevance. The course had 32 students, 75% female. It was quite successful with students exploring linked lists with music and trees through rendering scene graphs to generate animations. We ended up with a 91% success rate.

*The textbook Introduction to Computing and Programming in Python: A Multimedia Approach (by Guzdial) was published in December 2004 by Prentice-Hall. The Java version Introduction to Computing and Programming in Java: A Multimedia Approach (by Guzdial and Ericson) was just submitted to Prentice-Hall with an expected publication date of December 2005. We have just signed a contract with McGraw Hill for publication of the follow-on course textbook, Problem-solving with data structures: A multimedia approach.

*We again conducted a SIGCSE Workshop on media projects in CS1 and CS2, now in both Python and Java. The workshop completely sold-out, and our evaluation numbers were very highùabove the average of SIGCSE workshops. Several faculty made comments on their evaluations like these quotes: 'The presentation and the material were terrific. I got very inspired to introduce these ideas into my courses' and 'THANKS! - best 3 hour workshop I've attended. It went fast.'

*Undergraduate students continue to work with us to maintain and improve our course software.

During the 2003-2004 school year:

* We are continuing to develop the 'Introduction to Media Computation course'. It was offered to 305 students in Fall 2003 and 395 students in Spring 2004. The Spring offering was the first one to be taught by faculty at Georgia Tech other than the course developer.

* We continue to have higher retention than is common for CS1 courses. In Fall 2003, our WDF (Withdrawal, or D or F grade) was 12.5%. In Spring 2004, our WDF rate was 9.5%.

* We continue to be contacted by other institutions to aid them in adopting our whole class or portions of the course. These include Gainesville College, Kennesaw State University, DePauw University, Brandeis University, University of Maryland at College Park, and University of Illinois at Chicago.

* We are now developing Java versions of the course materials, more extensively earlier than originally planned. Because of our success in reaching non-CS majors with our media computation approach, the Georgia Department of Education contacted us about helping to develop workshops to teach high school teachers how to teach computer science. The state of Georgia has a goal of increasing the number of students who take Advanced Placement (AP) courses. Of the 350+ high schools in Georgia, there are only 40 AP teachers for computer science. The state is challenged to both teach teachers how to teach computing and to teach them how to teach AP CS. We are creating two summer workshops: A two week workshop to take non-programming teachers towards being able to program media computation and to be able to teach computing, and a one week workshop on helping programming-teachers to teach AP CS. Since the state of Georgia's programming curriculum requires a single programming language (Java, to meet the AP CS requirements), we are teaching both workshops in Java, and the two-week workshop maps to our media computation class for undergraduates.

For that workshop, we have started rewriting our Python text in Java (four chapters so far), and we have a contract with Prentice-Hall for publication in 2005. We have also produced PowerPoint slides for over 30 hours of instruction. The slides are freely available on the workshop website for use by the high school teachers and others.

Findings: (See PDF version submitted by PI at the end of the report)

2005

Tew, A. E., Fowler, C., & Guzdial, M. (2005). Tracking an innovation in introductory CS education from a research university to a two-year college, Proceedings of the 36th SIGCSE technical symposium on Computer science education. St. Louis, Missouri, USA: ACM Press.

In this paper, we compared the attitude changes and retention rates of the media computation course between Georgia Tech and Gainseville College, a two year public college in rural Georgia. The result was striking: Both institutions had a dramatic improvement in retention with the new course (nearly 90%), and women and minorities did as well as white males in both institutions.

Guzdial, M., & Forte, A. (2005). Design process for a non-majors computing course, Proceedings of the 36th SIGCSE technical symposium on Computer science education. St. Louis, Missouri, USA: ACM Press.

We conducted a follow-on survey of students in Spring 2004 who took our media computation course in Spring 2003 or Fall 2004 (one year or one semester later), to ask the course impacted them. 11% of the respondents had programmed since taking the course, and over 80% of the students said that the course had a continued impact on how they interacted with and thought about computers.

2004:
The major finding is that our proof-of-concept finding continues to hold true: The media computation approach is perceived as having greater relevance than more traditional introductory computer science approaches. In part because of that relevance, but also because of other factors in our approach (e.g., enhanced collaboration, open-ended and creative assignments), our retention rate is considerably higher than the national average for similar courses. This is now holding true even when teachers other than the original developer teach the course.

We are now developing evidence that the finding is true at other institutions. Gainesville College is reporting that they are having greater student success (i.e., lower WDF rate) since adopting the media computation approach. In particular, they are reporting greater retention of women.

Training and Development:

2006

Software development skills, including work in both Python and Java. As the project has grown larger, the students have developed the techniques necessary for open-source projects, including the use of unit tests and collaborative versioning systems.

Human subjects skills, including survey development and interviewing techniques.Qualitative and quantitative data analysis techniques, including use of hypothesis tests in tools like SPSS and use of qualitative coding mechanisms.

2005
We continue to work with undergraduates, in our evaluation studies, materials development, and software maintenance. Two graduate students, Jochen Rick and Allison Tew, are now working on the project.

2004:
For graduate students Rachel Fithian and Andrea Forte, and undergraduate students Lauren Ricch and Heather Perry, this project has offered their first opportunity to undertake research. All but Rachel have now published their first research findings from the media computation project.

Outreach Activities:

2005:
We continue to partner with the Georgia Tech Institute for Computing Education (ICE) and the Georgia Department of Education to provide high school teacher workshops building on our curricular materials, software, and approach.

Journal Publications

Forte, A and Guzdial, M, "Motivation and Non-majors in CS1: Identifying discrete audiences for introductory computer science", IEEE Transactions on Education, p. , vol. , (2004). Accepted,

A.E. Tew, C. Fowler & M. Guzdial, "Tracking an innovation in introductory CS education from a research university to a two-year college", Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, p. 1, vol. 1, (2005). Published, V.L. Almstrum, O. Hazzan, M. Guzdial, & M. Petre, "Challenges to computer science education research", Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, p. 1, vol. 1, (2005). Published,

B. Ericson, M. Guzdial, & M. Biggers, "A model for improving secondary CS education", Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, p. 1, vol. 1, (2005). Published,

M. Guzdial, & A. Forte, "Design process for a non-majors computing course", Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, p. 1, vol. 1, (2005). Published,

E. Aur, L. Irani, L. Barker, & M. Guzdial, "Contrasting women's experiences in computer science at different institutions", Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, p. 1, vol. 1, (2005). Published,

A. Forte, M. Guzdial, "Motivation and non-majors in computer science: Indentifying discrete audiences for introductory courses", IEEE Transactions on Education, p. 248-253, vol. 48(2), (2005). Published,

Books or Other One-time Publications

Mark Guzdial, "Introduction to Computing and Programming in Python: A Multimedia Approach", (2004). Book, Published
Bibliography: Prentice-Hall Publishers

Mark Guzdial and Barbara Ericson, "Introduction to Computing and Programming in Java: A Multimedia Approach", (2005). Book, Submitted
Bibliography: Prentice Hall

Web/Internet Site

URL(s):

http://coweb.cc.gatech.edu/mediaComp-plan;
http://coweb.cc.gatech.edu/mediaComp-teach;
http://coweb.cc.gatech.edu/cs1315;
http://coweb.cc.gatech.edu/cs1316

Description:

the first site is the main site for the research side of the project.

the second site is the website for the course. Since we use the same website (via our CoWeb, Collaborative Website software) for successive terms, the site serves as a repository for adopters of past homework assignments, exams, lecture slides, and syllabi.

Other Specific Products

Product Type:

Software (or netware)

Product Description:

The Hython Environment for Students (JES) is the programming environment for the course, running on Macintosh, Windows, and Linux.

Sharing Information:

JES continues to be developed and distributed as open source. Some schools, such as DePauw University, are teaching their own (related) courses (e.g., "Art and Algorithms") using JES.

Contributions

Contributions within Discipline:

2006:

Media Computation represents the first developed, documented, and well-studied example of a contextualized approach to computing education, an approach well-supported by existing learning sciences literature. As such, Media Computation presents a new kind of computing education approach, and provides an example of a new kind of theoretical support within computer science education.

2005:
We continue to lead computer science education research (a) in exploring an alternative approach to CS1 that dramatically improves retention, (b) in exploring how learning can and long term impact can be assessed for students in computing, and (c) in conducting careful analyses of our courses and our design goals.

2004:
The Media Computation approach is serving as model for how to approach non-majors computing courses.

Contributions to Other Disciplines:

2006:
Media Computation, while being used successfully, was first developed as an approach to teaching non-CS majors introductory computing, including programming. As computing becomes more important across disciplines, especially in science and engineering, it becomes more important to learn how to successfully teach computing in those other disciplines. The success of the Media Computation approach highlights a successful approach to teaching computing across the campus.

2005:
We are demonstrating the impact of teaching within a context, which is an approach that can be adopted by other disciplines (e.g., physics or math).

2004:
Our general approach is contextualizing (or 'tailoring') computer science to the students' majors and interests. Our evidence (see our resubmitted IEEE Transactions paper) suggests that this approach is effective for improving course retention in an engineering-specific CS1 as well as our own approach.

Contributions to Human Resource Development:

2006:
Media Computation, while being used successfully, was first developed as an approach to teaching non-CS majors introductory computing, including programming. As computing becomes more important across disciplines, especially in science and engineering, it becomes more important to learn how to successfully teach computing in those other disciplines. The success of the Media Computation approach highlights a successful approach to teaching computing across the campus.

2005:
We are dramatically increasing diversity and retention in our courses, and teaching others how to do the same.

2004:
There is extensive interest in this project in the area of computer science education. The following are the invited talks that the PI has given on the topic of this research in the 2003-2004 year:

Workshop on Women and Minorities in Computer Science, University of Colorado-Boulder, August 2003. 'Providing a Context to Motivate Non-Majors into Computing'

University of Virginia, 'Constructing Media as a Context for Teaching Computing and Motivating Women and Non-Majors', February 2, 2004.

University of Illinois-Chicago, 'Collaborative Dynabooks: A Research Agenda on Building Systems to Support Learning through Multimedia' and 'Constructing Media as a Context for Teaching Computing and Motivating Women and Non-Majors', March 9-10, 2004

Workshop at ACM SIGCSE 2004 (peer-reviewed), March 2004. 'Multimedia Construction Projects'

Georgia State University, 'Collaborative Dynabooks' A Research Agenda on Building Systems to Support Learning through Multimedia', March 23, 2004

Albany State University, 'Constructing Media as a Context for Teaching Computing and Motivating Women and Non-Majors', April 10, 2004

Workshop for the IMPACT program, for the University System of Georgia Board of Regents, 'Collaboration and cooperation in higher education: Research and Applications', April 23, 2004

University of Washington, 'Collaborative Dynabooks: A Research Agenda on Building Systems to Support Learning through Multimedia', May 18, 2004.

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Categories for which nothing is reported:

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Final Project Report on Introduction to Media Computation: A new CS1 Approach Aimed at Non-Majors and Under-Represented Populations NSF Grant #0306050

PI: Mark Guzdial
Georgia Institute of Technology

October, 2007

1 What are your major research findings?

We conducted several studies on Media Computation effectiveness over the course of the project.

- Retention has improved dramatically, from a 72% success rate (earning A, B, or C) in the previous course to 85-90% success rate in both courses, with similar results in other adopting schools (Tew et al., 2005). The introductory course is about 300 students/semester, and has an average 51% female population. The second course was 75% female in its first offering.
- In a previous interview study focusing on female students enrolled in the course, students found the course more relevant than the traditional first course (Rich et al., 2004a).
- Students report finding the course to be creative with a rich social context supported by an on-line environment for sharing media (Forte and Guzdial, 2004; Guzdial and Forte, 2005). Quoting from one female liberal arts student in an interview:

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

Below are specific findings reported on in these papers.

- In a comparison between a traditional CS1 and a Media Computation CS1, we found that women found the Media Computation approach more motivating (Rich et al., 2004b). We designed our study particularly to address issues raised in *Unlocking the Clubhouse* (Margolis and Fisher, 2002). We found that women in the Media Computation class found CS1 more creative, more social, and more relevant than our traditional CS1.

Table 1: Average non-CS majors success rates, in traditional CS1 (Fall '99 to Spring '03), and since, in *Media Computation* (Spring '03 to Fall '05)

Major	*Traditional CS1*	*Media Computation*
Architecture	46.7%	85.7%
Economics	54.5%	92.0%
History	46.5%	67.6%
Management	48.5%	87.8%
Public Policy	47.9%	85.4%

- In a comparison between three different introductory computing courses (traditional using Scheme, one for engineers using MATLAB, and a Media Computation CS1), we found that the contextualized approaches made remarkable gains in student retention (e.g., significantly lower withrawl-and-failure rates) and motivation (measured qualitatively with interviews) (Forte and Guzdial, 2005).
- After several semesters of using the same evaluation instruments at Georgia Tech and at Gainesville College, we found the both schools found similar results in terms of improved motivation toward computing classes and higher retention (Tew et al., 2005).
- In our theoretical piece that related our results with Media Computation to current learning sciences theory, especially situated learning (Mark Guzdial and Allison Elliot Tew, 2006), we published several summary results and findings that we hadn't published previously.

  Our lower withdrawl-and-failure rates reported in previous studies masked a more dramatic finding. Those results compared the CS1 that everyone at Georgia Tech had to take (which included science and engineering majors) with the Media Computation CS1 that only liberal arts, architecture, and management majors have to take. When we compare the Media Computation majors with how those same majors fared in the traditional CS1, the results are much more significant (Table 1).

  We also presented the results of our first longitudinal study. A year after the first offering of the course, we conducted an email survey of the students that had taken the course. Over a quarter (27%) of the respondents had manipulated new media since leaving the class, and 19% of the respondents had actually written programs since class had ended, mostly to manipulate media (Guzdial and Forte, 2005). In particular, students told us how much the class impacted how they interacted with computation.

  > "Definitely makes me think of what is going on behind the scenes of such programs like Photoshop and Illustrator."
  >
  > "I understand technological concepts more easily now; I am more willing and able to experience new things with computers now"
  >
  > "I have learned more about the big picture behind computer science and programming. This has helped me to figure out how to use programs that I've never used before, troubleshoot problems on my own computer, use programs that I was already familiar with in a more sophisticated way, and given me more confidence to try to problem solve, explore, and fix my computer."

At the end of our project, we began exploring how our audience (non-majors who make use of digital media) were appropriate comuter science education *after* graduation. We conducted a survey of graphics professionals who use Photoshop and who start to program, which was published at the 2006 *International Computing Education Research* workshop (Brian Dorn and Mark Guzdial, 2006). We found that the vast majority Photoshop programmers have virtually no formal computer science background (e.g., not even a course) and are not interested in books or courses on computer science. We found that there were significant needs among this audience (e.g., support for reuse and debugging). We now have a *Science of Design* grant to further explore how to teach computing to this audience.

References

Brian Dorn and Mark Guzdial (2006). Graphic designers who program as informal CS learners. In *Proceedings of the 2006 International Computing Education Research Workshop*. ACM: New York.

Forte, A. and Guzdial, M. (2004). Computers for communication, not calculation: Media as a motivation and context for learning. In *Hawaii International Conference on System Sciences*.

Forte, A. and Guzdial, M. (2005). Motivation and non-majors in computer science: Identifying discrete audiences for introductory courses. *IEEE Transactions on Education*, 48(2):248–253.

Guzdial, M. and Forte, A. (2005). Design process for a non-majors computing course. In *SIGCSE '05: Proceedings of the 36th SIGCSE technical symposium on Computer science education*, pages 361–365, New York, NY, USA. ACM Press.

Margolis, J. and Fisher, A. (2002). *Unlocking the Clubhouse: Women in Computing*. MIT Press.

Mark Guzdial and Allison Elliot Tew (2006). Imagineering inauthentic legitimate peripheral participation: An instructional design approach for motivating computing education. In *Proceedings of the International Computing Education Research Workshop*. ACM: New York.

Rich, L., Perry, H., and Guzdial, M. (2004a). A cs1 course designed to address interests of women. In *Proceedings of the ACM SIGCSE Conference*, pages 190–194, Norfolk, VA.

Rich, L., Perry, H., and Guzdial, M. (2004b). A cs1 course designed to address interests of women. In *Proceedings of the ACM SIGCSE Conference*, pages 190–194, Norfolk, VA.

Tew, A. E., Fowler, C., and Guzdial, M. (2005). Tracking an innovation in introductory cs education from a research university to a two-year college. In *SIGCSE '05: Proceedings of the 36th SIGCSE technical symposium on Computer science education*, pages 416–420, New York, NY, USA. ACM Press.

Final Project Report on Introduction to Media Computation: A new CS1 Approach Aimed at Non-Majors and Under-Represented Populations NSF Grant #0306050

PI: Mark Guzdial
Georgia Institute of Technology

October, 2007

Contents

1 What are your major research and education activities?

This project proposed three goals:

- to improve the development environment for students to tailor it better for this kind (Media Computation) of course,
- to develop Java-based versions of our materials for use by the greater majority of lower-division undergraduate CS courses, and
- to study the effects of these innovations and the ease of integration of media computation assignments into more traditional courses.

We accomplished all three in the four years of the project (three years plus one year of no-cost extension).

1.1 Improving the Development Environment

In the first year of the project, we integrated into *JES* (Jython Environment for Students) the ability to study picture and sound instances. Each of these tools allows the user to explore picture and sound instances via variable name. The picture Media Tool (Figure 1) allows the user to inspect the RGB values of any pixel, and to find the (x, y) coordinates of a given picture feature. These are important for designing and debugging image filters. The sound Media Tool (Figure 2) allows the user to inspect sample values in a sound and to figure out the index values for segments of the sound. These features are important for debugging sound filters and for finding index locations for digital splicing.

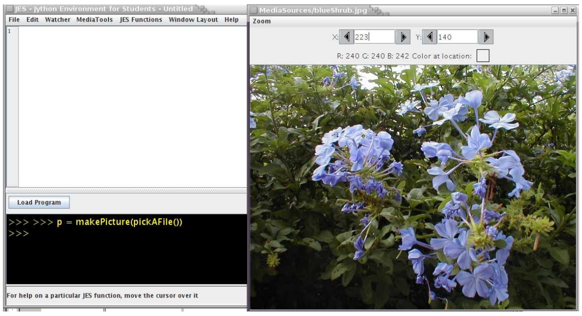

Figure 1: JES with Picture Media Tool Integrated

Figure 2: JES with Sound Media Tool Integrated

As our user community grew to multiple institutions, we recieved more feedback on the design and features of JES. We created a website for teachers (both post-secondary and high school) who use Media Computation: `http://coweb.cc.gatech.edu/mediaComp-teach`. We also created a mailing list (`mediacomp-teach@cc.gatech.edu`) for these teachers, through which bug reports and feature requests have been received.

One of the most common pieces of feedback we recieved was better integration with the help systems. In the last year of this grant, we made an extensive change to the help features of JES. The current version of JES (Figure 3) has context sensitive help, where clicking on a media function displays information on the parameters expected and provides one-click access to the explanation for that function.

We continued to use and develop our wiki-based *CoWeb* tool in support of the Media Computation approach. Other teachers adopting our approach are now also using CoWeb (also called *Swiki* and available at `http://wiki.squeak.org/swiki`). Jochen Rick, who developed the CoWeb and worked on the integration of the CoWeb into the Media Computation course, used this course as an example in a journal article for how to design collaborative technologies to create an open classroom culture (Rick and Guzdial, 2005).

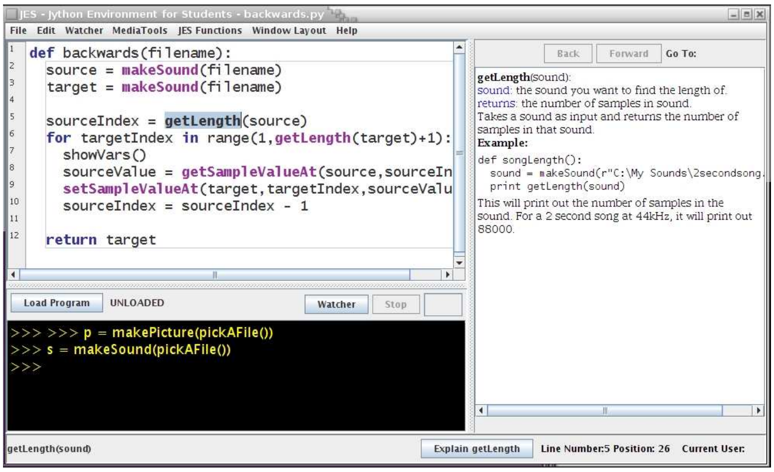

Figure 3: JES with help facilities available

1.2 Create Java-based Media Computation Materials

Soon after we started this project, the Georgia Department of Education approached us about adapting our Media Computation approach for use in training high school teachers to become computer science and even Computer Science Advanced Placement (CS AP) teachers. The Department of Education wanted to teach Java, since that is the current language of the CS AP exam.

With support of the state Department of Education, Barbara Ericson was hired by the College of Computing to develop these materials to teach these workshops. We worked with her, and the resultant materials were published by Prentice-Hall in 2006 (Guzdial and Ericson, 2006). We also share all the materials at the Media Computation website.

The Java approach is now neck-and-neck with the Python book in terms of course adoptions. Overall, over 50 schools that we know of are using one of the two texts. We also track schools that are using our approach but not either text—over 100 schools around the world are now using Media Computation assignments and lectures in their introductory courses.

We also began a data structures course, in Java, using a Media Computation approach. The driving question of the course is "How did the Wildebeests charge over the ridge in Disney's *The Lion King*?" In that scene (Figure 4), Disney for the first time did not draw nor script their characters. The wildebeests in that scene were modeled on a computer, and then a stampede situation was simulated. To explain that, we need linked lists and trees to explain how characters and scenes are modeled, and then stacks and queues to explain simulation. With a focus on the driving question, all of basic data structures is motivated and made relevant.

We have been teaching this class for over two years. We have recently completed an evaluation of the course which we published in the ACM *International Computing Education Research* Workshop (Yarosh and Guzdial, 2007), funded by our new CCLI grant. Two other schools (Gainesville and Lindfield Colleges) are now teaching a similar course using our materials. We have just signed a contract with Prentice-Hall for the new data structures text, with plans to publish that book in 2009.

Figure 4: The Wildebeests stampeding over the ridge in Disney's *The Lion King*

1.3 Studying Effects and Integration

Our original research proposed studying the effects of the Media Computation approach and studying the effort of integrating the new approach. We did not conduct the latter evaluation.

Our original hypothesis was that teachers would not adopt Media Computation without significant effort. Our plan then was to document that process with a few teachers, then use the documentation (a) to improve the process, where possible and (b) to inform others considering adoption. However, the rate of adoption quickly proved our hypothesis false. There were 25 schools adopting the Python Media Computation approach within the first year of publication of the textbook. The pace was such that we didn't keep up with the study, and didn't see a need to.

We did conduct several studies on Media Computation effectiveness over the course of the project.

- We conducted a study and published a paper on the how well the approach was appropriated by women (Rich et al., 2004).
- We published a paper in *IEEE Transactions on Education* comparing our traditional CS1, our Media Computation CS1, and a MATLAB-based CS1 for Engineers (Forte and Guzdial, 2005).
- After several semesters of using the same evaluation instruments at Georgia Tech and at Gainesville College, we published a paper comparing these results (Tew et al., 2005). That paper became frequently cited and its methods used to compare Media Computation results at other schools, e.g., (Sloan, 2006; Zografski, 2007).
- We published two papers describing the design process for Media Computation, to serve as a guide to others developing contextualized approaches to computing eduation (Forte and Guzdial, 2004; Guzdial and Forte, 2005).
- Finally, we published a theoretical piece that related our results with Media Computation to current learning sciences theory, especially situated learning (Mark Guzdial and Allison Elliot Tew, 2006).

At the end of our project, we began exploring how our audience (non-majors who make use of digital media) were appropriate comuter science education *after* graduation. We conducted a survey of graphics professionals who use Photoshop and who start to program, which was published at the 2006 *International Computing Education Research* workshop (Brian Dorn and Mark Guzdial, 2006).

References

Brian Dorn and Mark Guzdial (2006). Graphic designers who program as informal CS learners. In *Proceedings of the 2006 International Computing Education Research Workshop*. ACM: New York.

Forte, A. and Guzdial, M. (2004). Computers for communication, not calculation: Media as a motivation and context for learning. In *Hawaii International Conference on System Sciences*.

Forte, A. and Guzdial, M. (2005). Motivation and non-majors in computer science: Identifying discrete audiences for introductory courses. *IEEE Transactions on Education*, 48(2):248–253.

Guzdial, M. and Ericson, B. (2006). *Introduction to Computing and Programming in Java: A Multimedia Approach*. Prentice-Hall.

Guzdial, M. and Forte, A. (2005). Design process for a non-majors computing course. In *SIGCSE '05: Proceedings of the 36th SIGCSE technical symposium on Computer science education*, pages 361–365, New York, NY, USA. ACM Press.

Mark Guzdial and Allison Elliot Tew (2006). Imagineering inauthentic legitimate peripheral participation: An instructional design approach for motivating computing education. In *Proceedings of the International Computing Education Research Workshop*. ACM: New York.

Rich, L., Perry, H., and Guzdial, M. (2004). A cs1 course designed to address interests of women. In *Proceedings of the ACM SIGCSE Conference*, pages 190–194, Norfolk, VA.

Rick, J. and Guzdial, M. (2005). Situating CoWeb: A scholarship of application. *International Journal of Computer-Supported Collaborative Learning*. to appear.

Sloan, R. (2006). Presentation at nsf showcase at sigcse 2006: Results of media computation adaptation at university of illinois-chicago.

Tew, A. E., Fowler, C., and Guzdial, M. (2005). Tracking an innovation in introductory cs education from a research university to a two-year college. In *SIGCSE '05: Proceedings of the 36th SIGCSE technical symposium on Computer science education*, pages 416–420, New York, NY, USA. ACM Press.

Yarosh, S. and Guzdial, M. (2007). Narrating data structures: the role of context in cs2. In *ICER '07: Proceedings of the third international workshop on Computing education research*, pages 87–98, New York, NY, USA. ACM.

Zografski, Z. (2007). Innovating introductory computer science courses: approaches and comparisons. In *ACM-SE 45: Proceedings of the 45th annual southeast regional conference*, pages 478–483, New York, NY, USA. ACM.