

**Final Report for Period:** 08/2009 - 07/2010

**Submitted on:** 10/22/2010

**Principal Investigator:** Guzdial, Mark .

**Award ID:** 0618674

**Organization:** GA Tech Res Corp - GIT

**Submitted By:**

Guzdial, Mark - Principal Investigator

**Title:**

CCLI: Using Media Computation to Attract and Retain Students in Computing

### Project Participants

#### Senior Personnel

**Name:** Guzdial, Mark

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

#### Post-doc

#### Graduate Student

**Name:** Rudnick, Alex

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Yarosh, Lana

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Ni, Lijun

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** O'Neill, Brian

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Lead developer for JES programming environment

**Name:** Dorn, Brian

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Brian Dorn is working on JES, our Python (Jython) IDE developed for Media Computation. As an MS graduate and a CS PhD student with industry experience, he is helping us to improve our overall process and help to clean up the code after many undergraduate and graduate students have worked on it over the preceding 7 years.

#### Undergraduate Student

**Name:** Scharfnorth, William

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Developer for JES programming environment

#### Technician, Programmer

## Other Participant

### Research Experience for Undergraduates

#### Organizational Partners

#### Other Collaborators or Contacts

The three schools with whom we have had the most assessment collaboration are University of Illinois-Chicago, University of California at San Diego, and Columbus State University.

#### Activities and Findings

#### Research and Education Activities:

This summarizes the four main activity strands in our project.

**ACTIVITY 1: SUPPORT FOR EVALUATION:** We worked with several groups accessing and utilizing our instruments for assessing introductory computing courses linked to: <http://coweb.cc.gatech.edu/mediaComp-teach> . We worked with faculty around the country to support their efforts to evaluate their adoptions and adaptations of media computation curricula. Three examples during the scope of this project:

(1) A paper by Patrick Troy and Robert Sloan of the University of Illinois-Chicago on their 'CS0.5' course using media computation appeared in the March 2008 ACM SIGCSE 2008 Symposium. The 'CS0.5' course is for CS majors who lack the prior background to succeed at their first CS course (CS1). The results showed a dramatic increase in student success rates and in student motivation. This evaluation was particularly noteworthy because (a) they explicitly compare their results to those of Georgia Tech and Gainesville using our previously published measures, providing a cross-institutional comparison set and (b) they had a much more ethnically diverse course than any previously published study of use of media computation.

Sloan, R. H., & Troy, P. (2008). CS 0.5: a better approach to introductory computer science for majors. Paper presented at the Proceedings of the 39th SIGCSE technical symposium on Computer science education.

(2) Wayne Summers, professor and chair of Computer Science at Columbus State University, took our teacher workshop in June 2007. In Fall 2007, he taught a section of their CS1 class using Media Computation in Java, while another instructor taught two parallel sections using the same approach that they had used previously. The Media Computation section had lower failure rates (higher success rates) and greater student motivation than the traditional class. In Spring 2008, the students from all three sections took the same CS2 taught by the other instructor. There was no statistically significant difference between the Media Computation and traditional students on the midterm or final exam grades, or on the success

rates.

There are two important aspects to this study. First, this is the first study demonstrating a positive impact of Media Computation using Java on student retention. All previous studies used Python. Second, the success of the students in CS2, compared to the traditional context, is a measure of longer term success and equivalence of learning in CS1.

Wayne is preparing a paper for publication.

(3) The University of California at San Diego has adopted Media Computation Java in Fall 2008. We have been consulting with them on their evaluation of the implementation. During the Spring 2008 semester, Beth Simon conducted interviews with CS1 students to establish a baseline on students' motivation and attitudes. She has repeated the interviews in the Fall, and will again in the Spring. She tracked the students into their next semester.

Several interesting videos were created in the UCSD implementation of the class, including student videos (e.g., <http://www.youtube.com/watch?v=ZS1b8i7fcpM>) and interview videos (e.g., <http://video-jsoe.ucsd.edu/jsoe/Daniel/CSE8A/>).

Finally, an ITICSE 2010 paper was presented with very strong findings. Not only did the Media Computation students have a higher success rate than the traditional students, but the Media Computation students had significantly higher retention rates a year later. Media Computation students were more likely to stick with computer science a year later than students who had taken their previous kind of CS1. Simon, B., Kinnunen, P., Porter, L., & Zazkis, D. (2010). Experience Report: CS1 for Majors with Media Computation. Paper presented at the ACM Innovation and Technology in Computer Science Education Conference, Ankara, Turkey.

ACTIVITY 2: SUPPORT FOR MEDIA COMPUTATION PYTHON: O'Neill, Scharfnorth, and Dorn have developed various versions of JES (Jython Environment for Students), the IDE for the Python CS1 Media Computation course.

- JES 3.1 updated the version of Jython that we used to 2.2, the latest version. JES 3.1 also contained new support for movies, including the ability to 'play' JPEG frames and to write them out as AVI or MOV digital movie formats.
- JES 3.2 contained many fixes, including addressing some problems that arose with the Vista OS.
- More significantly, JES 4.2 is now zero-based -- all media indices start at zero, rather than one, for compatibility with the rest of Python.
- JES 4.2.1 fixes small bugs and also provides support for text input.

Because of growing interest in Media Computation Python, we were asked to create a Second Edition of that book. We completed that effort during Year 3 of this project, with the new (full-color book) published in early 2010.

We collaborate with two other projects that are implementing our API in C-based Python:

- \* The U. Toronto, led by Dr. Paul Gries, has results in a book 'Practical Programming: An Introduction to Computer Science Using Python' (<http://www.amazon.com/gp/product/1934356271>).
- \* The Institute for Personal Robotics in Education (IPRE,

<http://www.roboteducation.org>) has integrated media computation into their robotics tool, Myro, Doug Blank implemented our same API from JES for manipulation of images coming off the robot's camera.

#### ACTIVITY 3: STUDY OF AND SUPPORT FOR DATA STRUCTURES COURSE: A

significant part of this project has been to support the extension of the Media Computation approach into a CS2 course. Yarosh conducted a semester-long study using surveys and interviews of our CS2 media computation data structures course at Georgia Tech, to better understand the strengths and weaknesses of the approach. Her paper was published in the Proceedings of the ACM SIGCSE International Computing Education Research 2007 Workshop, and then it was re-published in the ACM Journal of Educational Resources in Computing (JERIC) in January 2008.

Our coursenotes for the Media Computation Data Structures course was rewritten as a textbook and turned over to the publisher, Pearson, during Summer 2008. The text was published in Jan 2010.

#### ACTIVITY 4: FACULTY DEVELOPMENT: We have offered eight national

workshops over the four years of the project: One as a preconference workshop at SIGCSE 2010, two in Atlanta, one in Boston, one in Cambridge, MA (6/16-6/18/2010), one at New Jersey Institute of Technology (7/5-7/6/2010) one in Chicago, and one at Claremont College (near Los Angeles). We have had 161 faculty attend workshops since we started. We asked faculty to complete a final survey with statements such as 'I found this workshop informative' and 'I can use the skills and knowledge from this workshop when I return to my school.' The scores have been uniformly very high, with over 90% strongly agreeing that the workshop was of high quality.

Because the PI was co-chair of the SIGCSE 2008 Program and co-chair of the SIGCSE 2009 Conference, we were unable to offer a workshop at SIGCSE 2008 or SIGCSE 2009 because of potential conflict-of-interest. Instead, we approached Pam Cutter and Alyce Brade of Kalamazoo College to offer the Python Media Computation workshop, and gave them all our materials. The workshop was accepted and was presented all three years years. A workshop evaluation was conducted, where the results were overwhelmingly positive. On the question, 'Overall, I thought the workshop was...' 11 of the 17 attendees in 2008 marked it 'Excellent,' and none marked it 'Fair' or 'Poor.'

We continue to scan and respond to questions on the Media Computation Teachers' mailing list, [mediacomp-teach@cc.gatech.edu](mailto:mediacomp-teach@cc.gatech.edu). Wonderful project ideas have been created by teachers and shared on this list, including analysis of MRI data, creating 3-D anagrams (red channel in one eye, blue in the other), and hiding messages inside of pictures.

At SIGCSE 2010, we organized a conference special session on all the variations on Media Computation that are developing around the country, from the robot implementations at Bryn-Mawr, to the port to Scheme at Grinnell College.

#### CONFERENCE PUBLICATIONS:

Yarosh, Svetlana & Mark Guzdial. (2007.) Narrating data structures: The role of context in CS2. Paper presented at the International Computing Education Research (ICER'07), Atlanta, GA. New York, NY:

ACM.

Ni, Lijun. (2009.) 'What makes CS teachers change?: Factors influencing CS teachers' adoption of curriculum innovations. Proceedings of the 40th ACM technical symposium on Computer science education. ACM Press: New York. 544-548.

Guzdial, M., Ranum, D., Miller, B., Simon, B., Ericson, B., Rebelsky, S. A., et al. (2010). Variations on a theme: role of media in motivating computing education. Paper presented at the Proceedings of the 41st ACM technical symposium on Computer science education.

### Findings:

From the studies coming in from different schools, we continue to find improvements in retention (e.g., lower failure and withdrawal rates) and student attitudes toward computer science using the Media Computation approach. From our own studies, we are getting a clearer picture of where the Media Computation context is useful, and what it takes to get teachers to adopt it.

= Work by Others=

Repeating the reports from the Activity section from three of these schools:

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Simon, B., Kinnunen, P., Porter, L., & Zazkis, D. (2010). Experience Report: CS1 for Majors with Media Computation. Paper presented at the ACM Innovation and Technology in Computer Science Education Conference, Ankara, Turkey.

= Work at Georgia Tech =

We have conducted two Media Computation related studies during the course of this project.

(1) Ni has been studying the variables influencing computer science teachers' adoption of new curricular approaches. She followed all teachers who took workshops sponsored by this CCLI grant and our BPC grant from the Summer 2007?she conducted interviews and gathered surveys from these teachers, then contacted them in the Fall to determine whether they did in fact make an adoption or adaptation. She found that we had a 50% adoption rate from the Media Computation workshop (where an adoption is either use of the approach in a whole course or an adaptation of parts of the approach in an existing course). She repeated this in November 2008. From 32 responses in the 2008 Media Computation workshops, 21 said 'yes' (adopted), 11 said 'no'. So we are having remarkably high effectiveness.

She conducted a logical regression, based on the collected survey data, with adoption as the outcome variable. The survey data asked about factors that other studies of teachers (mostly from science education) had identified as significant in teachers' decision-making about adopting reform curricula. She found that the most significant factor influencing adoption was teacher excitement about the approach ?that was far more significant than teacher belief that the approach would help students, or that the approach was supported by research findings. She found that the most significant factor influencing non-adoption was social or organizational issues, e.g., the teacher who needs to convince peers teaching other sections of the same course, or the department that

conducts a full faculty vote to decide textbooks for courses, etc.

These results were published in the SIGCSE 2009 paper: Ni, Lijun. (2009.) 'What makes CS teachers change?: Factors influencing CS teachers' adoption of curriculum innovations. Proceedings of the 40th ACM technical symposium on Computer science education. ACM Press: New York. 544-548.

(2) A significant part of this project has been to support the extension of the Media Computation approach into a CS2 course. Yarosh conducted a semester-long study using surveys and interviews of our CS2 media computation data structures course at Georgia Tech, to better understand the strengths and weaknesses of the approach. Her paper was published in the Proceedings of the ACM SIGCSE International Computing Education Research 2007 Workshop, and then it was re-published in the ACM Journal of Educational Resources in Computing (JERIC) in January 2008.

Lana's research question was 'Does Context still help in a second course?' Do students still find the media useful when now in a data structures course? She found that 11% of the class agreed with the statement 'Working with media is a waste of time that could be used to learn the material in greater depth.' However, a majority of the class (70%) agreed or strongly agreed that working with media makes the class more interesting. 67% of the students agreed or strongly agreed that they were really excited by at least one class project. 66% reported doing extra work on projects to make the outcome look 'cool.'

The final conclusion is that, overall, Media do play a significant role in maintaining motivation in the second course, but not for everyone. A percentage of the students (typically, we believe, the highest-achieving students) do not want to be slowed down by the media. The majority find it valuable, even in the second course.

Yarosh, Svetlana & Mark Guzdial. (2007.) Narrating data structures: The role of context in CS2. Paper presented at the International Computing Education Research (ICER'07), Atlanta, GA. New York, NY: ACM.

### **Training and Development:**

O'Neill and Dorn learned a great deal about managing a software development project that has real users, e.g., the importance of regression testing and testing on multiple platforms. Scharfnorth has learned about testing, from the same experiences, though not as team lead.

Both Ni and Yarosh have learned about evaluation techniques and the academic publication process.

### **Outreach Activities:**

Our CCLI Project works closely with our BPC Alliance, 'Georgia Computes!' (<http://www.gacomputes.org>). Media Computation approaches and tools are used in outreach, to middle school and high school students in summer camp settings, and in YWCA and Girl Scout activities.

### Journal Publications

Guzdial, M. and Tew, A.E., (2006) I, "Imagineering Inauthentic Legitimate Peripheral Participation: An Instructional Design Approach for Motivating Computing Education.", Proceedings of the Second International Computing Education Research Workshop, (Canterbury, UK), 51-58., p. , vol. , ( ). paper,

Yarosh, Svetlana & Mark Guzdial., "Narrating data structures: The role of context in CS2", Journal of Educational Resources in Computing, p. , vol. 7, (2008). Published,

### Books or Other One-time Publications

#### Web/Internet Site

**URL(s):**

<http://coweb.cc.gatech.edu/mediaComp-teach>

**Description:**

#### Other Specific Products

**Product Type:**

**Data or databases**

**Product Description:**

The Jython Environment for Students (JES) is publicly available, with source, at the same website.

**Sharing Information:**

- is publicly available, with source, at the same website

#### Contributions

**Contributions within Discipline:**

CS education is in a crisis of declining enrollments. Media Computation is an approach that attracts students (particularly the non-traditional students who mostly do not participate in computing classes, such as women and members of under-represented groups), improves retention in CS1, and improves attitudes toward computer science.

**Contributions to Other Disciplines:**

The general approach we are developing, a contextualized approach to STEM education, can help to make abstract ideas more concrete and approachable. We are describing our approach in general terms in our publications

**Contributions to Human Resource Development:**

The general approach we are developing, a contextualized approach to STEM education, can help to make abstract ideas more concrete and approachable. We are describing our approach in general terms in our publications

**Contributions to Resources for Research and Education:**

**Contributions Beyond Science and Engineering:**

#### Conference Proceedings

**Categories for which nothing is reported:**

Organizational Partners

Any Book

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Any Conference