Nomination Portfolio for

Mark Guzdial

Recipient of the 2001 Regents' Research in
Undergraduate Education Award
Research Universities

Nomination Narrative for
Mark Guzdial
For the FY2000 Regents' Research in Undergraduate Education Award

Dr. Mark Guzdial is an associate professor in the College of Computing at Georgia Institute of Technology. His research area is educational technology, with a special focus on technological support for *project-based learning*. Project-based learning is the use of an out-of-class project as a focus for learning experience. Guzdial's Ph.D. is in Education and Computer Science, where he was a co-author on one of the first papers describing how project-based learning worked (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palincsar, 1991).

Project-based learning is how much of the learning in Engineering and Computer Science takes place. Dr. Guzdial has had a great deal to work on since arriving at Georgia Tech in 1993. He has worked with faculty in Architecture, Biology, Chemical Engineering, Electrical Engineering, English Composition, Mathematics, and Mechnical Engineering in developing educational tools for classes at Georgia Tech. Last year, Tech awarded Dr. Guzdial its *Outstanding Interdisciplinary Activity Award* because of his cross-campus efforts.

Dr. Guzdial has worked on supporting undergraduate learning in other departments, but also in his own teaching. Dr. Guzdial teaches classes in educational technology and its development, but he also regularly teaches a required Sophomore object-oriented programming class, to over 100 students per term. Dr. Guzdial uses his technologies in his own classes, and he also studies his own classes and publishes those studies as research in Computer Science Education.

Research in CS Education: Objects and Design

Much of Dr. Guzdial's research in undergraduate education is in his own class. He has taught for over five years a class *Objects and Design*, on object-oriented programming and design methods. He started teaching the course in 1994, and he recognized a problem that the undergraduate students were having understanding object systems. He conducted a study and was able to describe the problem and its solution, which he published in the ACM SIG Computer Science Education conference proceedings (Guzdial, 1995). That paper has proved to be influential. It has been recently cited as important to the research program at U. California-Berkeley in this area (Clancy et al., 2001), and is being reprinted in the *Journal of Computer Science Education* this year (Guzdial, 2001a).

The class *Objects and Design* has as one of its goals the learning of design. Dr. Guzdial's research at U. Michigan dealt with issues of teaching design (Guzdial, Weingrad, Boyle, and Soloway, 1992; Soloway, Guzdial, Brade, Hohmann, Tabak, Weingrad, &

Blumenfeld, 1993). Here, he was dealing with helping undergrads learn what made for effective design. He turned to the work of his colleague, Janet Kolodner, who proposed the use of case libraries for facilitating the learning of design (e.g., Kolodner, 1995).

Dr. Guzdial wanted to create a case library that was made up of high-quality *student* work. His hypothesis was that student work would be more approachable than that of expert work. He asked his best undergraduates to consider volunteering their work in his class, and with them, he created a library of a dozen object-oriented design projects spread across some 1200 Web pages, STABLE (SmallTalk Apprenticeship Based Learning Environment). Working with Ph.D. student Colleen Kehoe, he conducted a set of comparison measures between previous terms of his class and the class using STABLE. He found that students using STABLE were able to solve more complex problems sooner and better than previous classes, and that their ability to diagnose and repair flawed designs was enhanced (Guzdial & Kehoe, 1998).

In 1998, Dr. Guzdial has introduced a new object-oriented programming language into this class, Squeak, making Georgia Tech the first institution in the world to be teaching Squeak to undergraduates. Squeak is a new (1995) programming language focused on object-oriented development of multimedia, being developed at Disney Imagineering. Dr. Guzdial has written the first textbook on Squeak (Guzdial, 2000), which has already been adopted at U. Michigan, Bucknell, Portland State, and Oregon Graduate Institute. His book includes case studies developed around student work, including (then) undergraduate Aibek Musaev and Ph.D. students Lex Spoon and Jochen Rick.

As part of his research into undergraduate learning, Dr. Guzdial conducted a study of student learning on a complex concept in user interfaces. Previous to his use of Squeak, he used a traditional textbook and traditional language, and he had started recording data on students' problems with this concept. With Squeak, he was able to try a different approach. In comparison with previous classes, performance on isomorphic problems jumped significantly (from 50-60% to over 80% average score), which is being published next month at the ACM SIG Computer Science Education conference (Guzdial, 2001b).

Research on Collaboration for Undergraduate Learning

One of the focal areas in Dr. Guzdial's research is on the role of collaboration to support and enhance project-based learning. His computer-supported collaborative learning (CSCL) environments are the ones that he uses in classes across campus, as well as in his own.

- His tool, CaMILE, was first used in Mechanical Engineering classes (Guzdial, Vanegas, Mistree, Rosen, Allen, Turns, & Carlson, 1995; Turns, Mistree, Rosen, Allen, Guzdial, & Carlson, 1995), but was later used in LCC, History, and CS classes as well. CaMILE was developed with Ph.D. students David Carlson and Noel Rappin, and was evaluated with Ph.D. student Jennifer Turns.
- His current tool, the CoWeb (Collaborative Website), is being used across campus. He hosts over 50 classes at Georgia Tech on his ten servers via CoWebs. The CoWeb

was originally developed by Dr. Guzdial, but is now jointly developed by undergrads and graduate students working with him at the College of Computing.

Dr. Guzdial's research in collaborative learning has focused on what makes students participate in collaborative learning situations. His research with Jennifer Turns (Guzdial & Turns, 2000) has shown that his Web-based tools are more effective in encouraging sustained discussion than more traditional newsgroup-like tools. Through head-to-head comparisons across sections of the same undergraduate course, and via larger studies crossing many undergraduate courses (17) in several departments at Tech, they showed that students using *anchored* Web-based tools carried on significantly more sustained discussions than those using newsgroups.

Research on Computer Modeling

With faculty in Chemical Engineering (Drs. Realff and Ludovice) and Mathematics (Dr. Morley), Dr. Guzdial has been studying how to help undergraduates learn computer modeling better—a critical skill for engineers today. With Ph.D student Noel Rappin, their first effort was a tool to aid Chemical Engineering students, called DEVICE (Rappin, Guzdial, Ludovice, & Realff, 1995; Rappin, Guzdial, Reallf, & Ludovice, 1997; Rappin, Guzdial, Realff, & Ludovice, 2001). DEVICE was able to significantly improve student performance on chemical engineering pump problems, and also improve learning, as demonstrated by paper-and-pencil problems away from the software.

Noel Rappin's thesis extended the work of DEVICE into Computer Science modeling, by going back to Dr. Guzdial's *Objects and Design* class in order to study learning about object-oriented modeling. Dr. Rappin created a tool, BOOST, which students used to create models of their object systems. He showed that BOOST-using students developed a significantly better modeling process than did students working with other modeling tools. Dr. Rappin's thesis demonstrated a framework, used in both DEVICE and BOOST, that leads to better learning of computer modeling.

Summary

Dr. Guzdial's scholarship in undergraduate education begins in his own class, but then extends across the campus into many other departments. His work in computer science education has impacted departments across the country, and his scholarship has led to several significant publications. His work in other areas of undergraduate education (e.g., collaboration and computer modeling) has led to significant publications in these areas as well. His work has shown excellence in undergraduate education research, and has involved students at both the undergraduate and graduate levels as assistants in this work.

References

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Guzdial, M., & Kehoe, C. (1998). Apprenticeship-based learning environments: A principled approach to providing software-realized scaffolding through hypermedia. *Journal of Interactive Learning Research, 9*(3/4), 289-336.

Guzdial, M. (2000). *Squeak: Object-oriented design with Multimedia Applications*. Englewood, NJ: Prentice-Hall.

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January 18, 2001

Dr. Dorothy Zinmeister
Senior Associate for Academic Affairs
Board of Regents of the University of Georgia
270 Washington Street, SW
Atlanta, Georgia 30334

**RE: Nomination of Dr. Mark Guzdial for the FY 2001 Regents' Research in
Undergraduate Education Award**

Dear Dr. Zinmeister

It is my pleasure to submit this nomination for Dr. Mark Guzdial for the 2001 Regents'
Research in Undergraduate Education Award. Dr. Guzdial was the winner of the 2000
Class of 1934 Outstanding Interdisciplinary Activity Award at Georgia Tech in
recognition of the interdisciplinary nature of his research. What is most surprising about
this work is that it is educational in nature – while many of our faculty are active
interdisciplinary researchers, few extend their interest in teaching and learning beyond
their own area of formal expertise.

As is apparent from the letters and documents in this packet, Dr. Guzdial is extremely
active not only in the area of teaching students how to program, but more broadly, the
area of using computers to enhance collaborative learning. He is committed to
researching how faculty and students can use computer technology to increase the
collaboration among the members of a class (and across classes, both in space and time).
Mark is intent on learning how our undergraduate students learn and whenever he gets a
glimpse at what will help students learn, he wants to figure out how to make technology
make this occur with more certainty.

This is not just a side interest for Mark – it is the very basis of his scholarship. There is
no separation for Mark between his teaching and his research, he is always engaged in his
research even when lecturing, and he is always teaching, even when in his lab. Indeed
the letters from his graduate students illustrate two important points about Mark's work.
First, his students are his colleagues. He engages his students in the research endeavor as
peers worthy of his respect and time. Second, he uses the research setting to teach his
students. These students are learning valuable lessons about educational research of
course, but in addition, they are learning about how to do research, how to work with real
students in real classrooms, and how to turn intuition into scholarly work.

What perhaps is missing from the other documents in this packet is the enthusiasm that Mark inspires in the other faculty on campus. Mark regularly gets faculty in diverse units talking about teaching and learning issues – about how to experiment (and document those experiments) with different tools and approaches in order to improve student learning. He has definitely increased the dialogue on campus about the scholarship of teaching. In closing, we are proud of Mark and his accomplishments, and are pleased to present this packet for your consideration.

Sincerely,

Michael E. Thomas
Provost and Vice President for Academic Affairs

MARK J. GUZDIAL
Associate Professor
College of Computing
Georgia Institute of Technology

EDUCATIONAL BACKGROUND

Ph.D.	1993	University of Michigan	Education and Computer Science and Engineering
M.S.	1986	University of Michigan	Computer Science and Engineering
B.S.	1984	Wayne State University	Computer Science

CURRENT FIELDS OF INTEREST

Educational computing, computer-supported collaborative learning, multimedia composition environments, design environments for students, computational science (computer modeling, simulation, and visualization) for students, software-realized scaffolding, log file analysis.

Dr. Guzdial's current research centers on facilitating project-based learning: student learning through doing. He focuses on computer-supported collaborative learning, support for modeling, and project case libraries. He is developing theory on how educational developers design, implement, and evaluate educational technology to support student activity. His Collaborative Software Lab has the goal of enabling collaborative *DynaBooks*, in reference to the early vision of the computer as a personal tool for creating, experiencing, and sharing dynamic media for learning. Dr. Guzdial uses a variety of techniques to evaluate the usability and learnability of the environments he creates, and he is a leader in developing techniques for analysis of user event traces (log files).

Courses Taught

Quarter/Year	Course	Number of Students
Spring 2000	CS2340 Objects and Design	171
Summer 2000	CS2340 Objects and Design (w/Rich LeBlanc)	101
Fall 2000	CS4660 Educational Technology	41
Spring 2001	CS4670 and CS7567 Computer Supported Collaborative Learning	24

Curriculum Development

Developed three new courses:
> *CS 6397   Educational Technology*
> Introduction to educational technology. Review of philosophies/approaches (apprenticeship, tutoring), technologies (collaborative learning, multimedia), issues impacting effective use of technology (teachers, classroom culture), and assessment.
> *CS 6398   Design & Analysis of Educational Software*
> Student teams design, implement, and analyze educational software. Topics include educational software types, design approaches, and formative evaluation techniques (interviews, log file analysis).
> *CS4670 and CS7567   Computer-Supported Collaborative Learning*
> Introduction to theory, practice, implementation, and evaluation of computer-supported collaborative learning. Undergraduate and graduate versions of the course are defined and will be taught concurrently.

In-Development for Fall 2001:
> *Computer Music*
> An undergraduate course on the algorithms used to generate sounds and music with a computer. Includes algorithmic composition.

Selected Published Journal Papers

> Blumenfeld, P.C., E. Soloway, R.W. Marx, J.S. Krajcik, M. Guzdial, and A. Palincsar. (1991) "Motivating project-based learning: Sustaining the doing, supporting the learning." *Educational Psychologist, 26*(3 & 4). pp. 369-398

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Books

Guzdial M., Weingarten F., eds. (1997) *Setting a Computer Science Research Agenda for Educational Technology*. Washington, DC: CRA.

Guzdial, M. (2000). *Squeak: Object-oriented design with Multimedia Applications*. Englewood, NJ: Prentice-Hall.

Guzdial, M., & Rose, K. (Eds.). (2001). *Squeak, Open Personal Computing for Multimedia.* Englewood, NJ: Prentice-Hall. (Expected in April)

Invited Keynote addresses

Guzdial, M. (1998) "Computer Support for Apprenticeship in Software Engineering." Keynote Address. International Conference of Software Engineering Education and Training. Atlanta, GA. February.

Guzdial, M. (1998). "Technological Support for an Apprenticeship-Based Computer Science Education." Keynote Address. ACM Southeast Regional Conference. Marietta, GA. April.

Guzdial, M. (1998). "Technological Support for Project-Based Learning." Invited Keynote Address. CALISCE'98: 4th International Conference on Computer Aided Learning and Instruction in Science and Engineering. Göteborg, Sweden. June.

Conference Papers

Guzdial M. (1995) "Centralized mindset: A student problem with object-oriented programming." *ACM SIGCSE Technical Symposium 1995*. New York: ACM Press: 182-185.

Abowd, G., Pimentel, M. d. G., Kerimbaev, B., Ishiguro, Y., & Guzdial, M. (1999). Anchoring discussions in lecture: An approach to collaboratively extending classroom digital media, *Proceedings of CSCL'99* (pp. 11-19). Palo Alto, CA.

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Craig, D., ul-Haq, S., Khan, S., Zimring, C., Kehoe, C., Rick, J., & Guzdial, M. (2000). *Using an unstructured collaboration tool to support peer interaction in large college classes.* Paper presented at the International Conference of the Learning Sciences 2000, Ann Arbor, MI. 178-184.

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Current Funding

Project Title:	Integrating Learning Across Undergraduate Engineering Curriculum through Technology-Supported Collaboration
Co-PIs:	Mark Guzdial, Matthew Realff, Pete Ludovice, Tom Morley
Amount Funded:	NSF REPP $620,000
Period Covered:	1/1/99-12/31/02
Project Title:	Cost-Effective Uses of the CoWeb Collaborative Learning Technology to Improve Higher Education
Co-PIs:	Mark Guzdial
Amount Funded:	Mellon Foundation $240,000
Period Covered:	1/1/00-5/31/02
Project Title:	Ectropic Design: Intelligent Collaboration Spaces for Open Software
Co-PIs:	Spencer Rugaber and Mark Guzdial
Amount Funded:	NSF, CISE Division $200,000
Period Covered:	1/1/01-12/31/02
Project Title:	Scaffolded Work Environments for Learning
Co-PIs:	Elliot Soloway (PI, U.Michigan), Edelson, Reiser (Northwestern), Moher, Johnson (U. Chicago-Ill.), Guzdial (GaTech)
Amount Funded:	NSF ITR (CISE) $2,999,999 – subcontract to Georgia Tech, $350,000
Period Covered:	1/1/01-12/31/03