

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

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| NSF 09-602 | | | 10/05/09 | | NSF PROPOSAL NUMBER | |
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| DRL - DISCOVERY RESEARCH K-12 | | | | | | |
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| TITLE OF PROPOSED PROJECT DR K-12: Computer-Supported Math Cognition Through Shared Visualizations and Collaborative Discourse | | | | | | |
| REQUESTED AMOUNT \$ | PROPOSED DURATION (1-60 MONTHS) | REQUESTED STARTING DATE | SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE | | | |
| 2,924,147 | 60 months | 09/01/10 | | | | |
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COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

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| NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE Rutgers University Newark | | | ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE Rutgers University Newark 249 University Avenue Newark, NJ. 071021896 | | | |
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| TITLE OF PROPOSED PROJECT | | | | | | |
| REQUESTED AMOUNT \$ 565,158 | | PROPOSED DURATION (1-60 MONTHS) 0 months | | REQUESTED STARTING DATE | | SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE |
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| <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____ | | | | | | |
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DR K-12: Computer-Supported Math Cognition Through Shared Visualizations and Collaborative Discourse

This full research and development project designs, develops and tests an interrelated system of technological, pedagogical and analytic components to provide a range of opportunities for middle- and high-school students to engage in significant mathematical discourse (DR K-12 challenge 2). It catalyzes and supports these opportunities by enhancing the ability of in- and pre-service teachers to engage in, appreciate and foster significant math-problem-exploration and math-discourse-analytic skills (DR K-12 challenge 3). The project addresses the core STEM discipline of mathematics by motivating the appreciation, comprehension and enjoyment of mathematical cognitive skills through socially interactive, collaborative learning experiences involving pedagogically organized series of stimulating, skill-appropriate problems using computer-based visualization/exploration and small-group math discourse.

The project adopts an iterative design-based-research approach to develop a socio-technical *educational model* that evolves and integrates a number of mutually supportive components: (a) *Innovative technology*: A custom, open-source virtual learning environment that integrates synchronous and asynchronous media with the first multi-user dynamic-math-visualization application. (b) *Curricular resources*: Problem-based learning curricula in specific areas of mathematics designed to help teachers tune rich math problems to student capabilities and to guide student exploration. (c) *In-service teacher training*: Practicing teachers are taught to understand and model the innovative technologies and pedagogies by doing online collaborative problem solving/posing/exploration and engaging in collaborative reflection on their own logged interactions. (d) *Pre-service teacher training*: Future teachers next do likewise, but now mentored by the in-service teachers. (e) *Middle- and high-school students*: The teachers then introduce the technology and curricular resources into their classrooms, taking the logs of their students' online interactions to the students and back to their training sessions for group reflections.

The project builds on previous work of the PIs, including: the discourse-analysis-based theory of group cognition (Stahl, 2006); a virtual learning environment developed, analyzed and evaluated in (Stahl, 2009); math educational materials developed in (Powell, Lai & O'Hara, 2009) and tested in Math Forum Spring Fests 2005, 2006, 2007; curricular materials and dynamic math visualization software of GeoGebra, adapted to multi-user collaborative learning; training of in- & pre-service math teachers at Drexel and Rutgers; and the adaptation of conversation analysis to text-based chat interaction analysis (Zemel, Çakir & Stahl, 2009), designed to highlight where, how and why collaborative problem solving or group knowledge building takes place. Project key personnel and Advisory Committee members bring expertise in educational software R&D; math curriculum development, dissemination & mentoring; in- & pre-service teacher training; online math resources, collaborative learning, problem-based learning & dynamic math; design-based educational research management & evaluation; theory of knowledge building in small groups & in online communities (Renninger & Shumar, 2002; Stahl & Hesse, 2006).

Intellectual merit. This project integrates leading-edge virtual learning-environment technology incorporating innovative collaborative math exploration tools with curricular approaches based on current directions in the learning sciences. It approaches this through a systematic iterative process of co-evolving the technology and curricular resources in the context of engaging, reflective collaborative-learning experiences of significant mathematical discourse by in- & pre-service teachers and their students. It thereby advances theory, technology and practice within real-world educational settings.

Broader impact. The project designs, tests and disseminates technology, curricular resources, pedagogical methods and analytic tools for use in math-teacher training and professional development programs, classrooms of math students, home-schooling networks, online schools and the Math Forum community (over three million visits per month). Project results will support the use of math exploration technology within collaborative math discourse approaches at diverse urban schools around Philadelphia and Newark, and nationally—bringing practical cyberlearning of math to at-risk students.

DR K-12: Computer-Supported Math Cognition Through Shared Visualizations and Collaborative Discourse

This project pursues the following research question:

*How to leverage (i) customized **technology** for computer support of shared math **visualization** and joint **exploration**, (ii) innovative **models** of math learning through collaborative **discourse** and (iii) research-based teaching **resources** to foster **math cognition** in math-discourse teams of in- and pre-service **teachers** or of middle- and high-school **students**?*

Mathematics education in the future faces enormous opportunities from the availability of ubiquitous digital networks, from innovative educational approaches based on theories of collaborative learning and from rich resources for interactive, online, dynamic math exploration. A major issue in realizing these opportunities on a broad scale in schools is empowering practicing and future teachers to appreciate the new approaches, and supporting them with appropriate tools, models and resources for classroom usage.

This project therefore proposes to develop a virtual learning environment that integrates synchronous and asynchronous media with an innovative multi-user version of a dynamic math visualization and exploration toolbox. In-service teachers will be introduced to the collaborative exploration of core math topics in this environment. They will then be guided in reflection on their own team's discourse with the use of chat-replaying and discourse-analysis visualization tools. As they become familiar with the use of the technology and with the nature of collaborative math discourse, the in-service teachers will mentor pre-service teachers through a similar process of engagement. Finally, both groups of teachers will introduce their students—primarily in diverse urban schools—to experiences of mathematical exploration and to reflection on math team discourse.

To mathematicians since Euclid, math represents the paradigm of creative intellectual activity. Its methods set the standard throughout Western civilization for rigorous thought, problem solving and argumentation. We teach geometry to instill in students a sense of deductive reasoning. Yet, too many students—and even some math teachers—end up saying that they “hate math” and that “math is boring” or that they are “not good at math.” They have somehow missed the true experience of math cognition—and this may limit their lifelong interest in science, engineering and technology. According to a recent “cognitive history” of the origin of deduction in Greek mathematics (Netz, 1999), the primordial math experience in 5th and 4th Century BC was based on the confluence of labeled geometric diagrams (shared visualizations) and a language of written mathematics (asynch collaborative discourse), that supported the rapid evolution of math cognition in a small community of math discourse around the Mediterranean.

The learning sciences have transformed our vision of education in the future (Sawyer, 2006; Stahl, Koschmann & Suthers, 2006). New theories of mathematical cognition (Bransford, Brown & Cocking, 1999; Brown & Campione, 1994; Greeno & Goldman, 1998; Hall & Stevens, 1995; Lakatos, 1976; Lemke, 1993; Livingston, 1999) and math education (Cobb, Yackel & McClain, 2000; Lockhart, 2009), in particular, stress collaborative knowledge building (Bereiter, 2002; Scardamalia & Bereiter, 1996; Schwarz, 1997), problem-based learning (Barrows, 1994; Koschmann, Glenn & Conlee, 1997; Moss & Beatty, 2006; Renninger & Shumar, 1998), dialogicality (Wegerif, 2007), argumentation (Andriessen, Baker & Suthers, 2003), accountable talk (Michaels, O'Connor & Resnick, 2008), group cognition (Stahl, 2006), and engagement in math discourse (Sfard, 2008; Stahl, 2008). These approaches place the focus on problem solving, problem posing, exploration of alternative strategies, inter-animation of perspectives, verbal articulation, argumentation, deductive reasoning and heuristics as features of significant math discourse (Powell, Francisco & Maher, 2003). By bringing thinking and learning to word, they make cognition public and visible. This requires a reorientation of the teaching profession to facilitate dialogical student practices as well as providing content and resources to guide and support the student discourses. Teachers and students must learn to adopt, appreciate and take advantage of the visible nature of collaborative learning. The emphasis on text-based collaborative learning can be well supported by computers with appropriate computer-supported collaborative learning (CSCL) software.

The proposed project will design, develop and test two forms of *technology* with demonstrated potentials for math education: (i) CSCL software and (ii) dynamic mathematics (software that allows users to manipulate geometric diagrams, equations, etc.). CSCL provides virtual learning environments in which small teams of students can interact synchronously and asynchronously to build knowledge together. This student-centered approach has many advantages, including increased motivation, sharing of skills, engaging in significant discourse and practicing teamwork. Dynamic math (such as Geometer's Sketchpad, Mathematica, Cabri or GeoGebra) has already greatly impacted math education, with Geometer's Sketchpad used in many US classrooms and GeoGebra used globally (Goldenberg, 1995; Hoyles & Noss, 1994; King & Schattschneider, 1997; Laborde, 1998; Scher, 2002). GeoGebra (<http://www.geogebra.org>) is an open source system for dynamic geometry, algebra and beginning calculus—including trigonometry, conics, matrices, graphing and Euclidean constructions. It offers multiple representations of objects in its graphics, algebra and spreadsheet views that are all dynamically linked, making GeoGebra the most flexible tool for exploration. Working with the developers of GeoGebra, this project will provide the first multi-user version of dynamic math, so that student teams can explore math collaboratively; it will integrate this into a larger virtual collaborative-learning environment with text chat and integrated wiki to support persistent discourses about math—that can be shared, reflected on and researched.

The proposed project will design, develop and test *models* of math education through collaborative math problem solving/proposing/exploring, by having in-service and pre-service teachers experience these models first-hand and reflect on their own learning experiences. Then they will try out these models with their own students, while receiving mentoring and support from the project. The collaborative model of math education stresses math discourse. To learn math is to participate in a mathematical discourse community (Lave & Wenger, 1991; Sfard, 2008; Vygotsky, 1930/1978), which includes people literate in and conversant with topics in mathematics beyond practical arithmetic. Learning to “speak math” is best done by sharing and discussing rich math experiences within a supportive math discourse community (Papert, 1980; van Aalst, 2009). Training and scaffolding is also critical for effective collaborative knowledge building (Fischer et al., 2006; Hakkarainen, 2009). Collaborative knowledge practices can be supported through group roles, team processes, feedback mechanisms, prompts, sentence starters, problem design/phasing, group formation and socializing (Stegmann, Weinberger & Fischer, 2007). In this project, we propose using teachers' and their students' original mathematical conversations as “didactic objects” (Thompson, 2002) designed to support “decentering” (Wolvin & Coakley, 1993) and “collective reflection” (Cobb et al., 1997) on particular aspects of their math cognition.

The proposed project will design, develop and test *resources* to support the teachers and students in their interactive explorations of rich math problems (e.g., problems with multiple possible solution approaches and many potential extensions to explore). Two main resources are (i) curriculum packages in several domains of math (Powell, Lai & O'Hara, 2009) and (ii) training in interaction analysis (Jordan & Henderson, 1995; Psathas, 1995; Sacks, Schegloff & Jefferson, 1974; ten Have, 1999; Zemel, Çakir & Stahl, 2009; Zemel, Xhafa & Çakir, 2007) to help teachers and students make sense of logs of their math discourses. These two broad categories of resources will encapsulate the expertise of the project team in problem design and in discourse analysis, producing documents that can be used by a gradually growing community of math teachers and students. The content of these resources will build on experience at the Math Forum, the VMT Project, the teacher training programs at Drexel and Rutgers and the related research literature; it will be elaborated, tested, evaluated and refined during the course of the project.

Results from Prior NSF Support

The proposed project grows out of the successful Virtual Math Teams (VMT) Project, which just concluded. This was a six-year NSF project (awards DUE-0333493, IERI-0325447, SBE-0518477, DRL-0723580) that developed an open-source virtual learning environment for math students. The system

integrated a social-networking portal, synchronous text chat, a shared whiteboard, an asynchronous wiki, a referencing tool, mathML expressions and a web browser. Student actions and chat postings are automatically logged to be replayed for analysis. Over a thousand student-hours of piloted usage were logged. A qualitative micro-analytic approach to interaction analysis was developed based on ethnomethodologically inspired conversation analysis. A large number of publications have appeared from the project, including two books (Stahl, 2006; 2009) and six doctoral dissertations (Çakir, 2009; Litz, 2007; Mühlpfordt, 2008; Sarmiento-Klapper, 2009; Wee, 2009; Zhou, 2009). The VMT Project was structured as design-based research, with the technology, educational model and problem resources co-evolving through dozens of iterations. The VMT Project demonstrated both the practicality of the proposed project and the need for it. The VMT Project provides a solid starting point for the proposed project and documents the need for further technological development, enhanced support for dynamic math, curricular models and training of in- and pre-service teachers. The design, development and testing of these further steps are needed to enable a powerful and innovative form of math education to be offered in a practical form to K-12 schools through education schools and to the public through the Math Forum.

Research and Development Design

The proposed project adopts an iterative design-based-research approach to design, develop and test innovative curriculum materials, technologies, teaching methods and models for teacher preparation, in-service professional development and student learning. The project develops a socio-technical educational model that evolves and integrates a number of mutually supportive components:

- (a) *Innovative technology.* A custom, open-source virtual learning environment that integrates synchronous (text chat, shared whiteboard, GeoGebra dynamic math exploration, shared web-browser) and asynchronous (a community wiki, a social-networking portal) media to support math visualization and collaborative discourse by small virtual math teams. [Leads: Goggins, Weusijana]
- (b) *Curricular materials.* Problem-based learning (PBL) (Barrows, 1994; Hmelo-Silver, 2004; Koschmann, Glenn & Conlee, 2000) curricula in areas of mathematics like combinatorics and Euclidean geometry will be developed and piloted. These curricular packages (Krause, 1986; Math Forum & Wolk-Stanley, 2003a; 2003b; 2004a; 2004b; Powell et al., 2009) will help teachers to tune the math problems to student capabilities and will guide students in relating findings or in creatively exploring rich but accessible domains. [Leads: Fetter, Powell & Underwood]
- (c) *In-service teacher training.* To effectively change education in schools, practicing teachers must be prepared to understand and model the innovative technologies and pedagogies. This project starts by involving in-service teachers in online collaborative problem solving using the project's software technology (a, above) and curricular materials (b). The in-service teachers also engage in collaborative reflection on their own logged online interactions. [Leads: Powell & Silverman]
- (d) *Pre-service teacher training.* The project next involves future teachers in a process similar to (c), but now mentored by in-service teachers. Both Drexel and Newark offer pre-service certification programs and in-service masters degrees in online and blended formats, lending themselves to use of the project technology to capture explorations in GeoGebra as well as group reflections on the logs. Teachers from Drexel and Rutgers can be mixed in online teams. [Leads: Powell & Silverman]
- (e) *Middle- and high-school students.* The in-service (c) and pre-service teachers (d) then introduce the technology (a) and curricular resources (b) into their classrooms, often mixing students from different schools or cities to take advantage of being part of an online discourse community. The teachers take the logs of their students' interactions back to their training sessions for group analysis. They also engage their students in reflection on their own logs. [Leads: Clay, Fetter & Weimar]
- (f) *Broader math-discourse communities.* Once teachers studying at Drexel or Rutgers and their students become involved in online collaborative dynamic geometry and math discourse, teams will be set up

that involve students from online schools, home schooling networks or the Math Forum community. This will yield data for generalizing project findings as well as stimulate the spontaneous generation of self-organizing communities of math discourse (Renninger & Shumar, 2002). [Lead: Shumar]

- (g) *Interaction analysis*. Logs of math discourse are automatically generated and easily downloadable for analysis of problem solving, deductive reasoning and strategic math heuristics by students, teachers and researchers. The project will provide methods of interaction analysis to guide the understanding of logged math discourses. [Lead: Zemel]
- (h) *Group cognition theory*. When small groups engage in collaborative problem solving/posing/exploring, they can accomplish cognitive tasks interactively or transactively as a group. The project will analyze logs of student math work, shared visualizations and reflective discourse, using conversational analysis and statistical methods to study how students build on each other's utterances, constructions and actions to accomplish mathematical cognition. [Lead: Goggins]
- (i) *Evaluation*. The interaction analysis of logged math discourses by teachers and students will drive the cycles of design-based research and provide a foundation for formative and summative project evaluation. By helping the project research team to identify and understand how math problem solving takes place under the existing configuration of project components and conditions, the interaction analysis will suggest next steps to try and will provide meaningful empirical feedback on project progress. [Leads: Khoo & Forte]

The proposed project builds on previous work of the PIs, including:

- The theory of group cognition (Stahl, 2006).
- The Virtual Math Teams (VMT) online learning environment developed, analyzed and evaluated in (Stahl, 2009).
- The field of computer-supported collaborative learning (CSCL), documented in (Stahl & Hesse, 2006)
- Curricular materials in combinatorics (patterns & permutations) developed in (Powell et al., 2009) and tested in VMT Spring Fest 2005, 2006, 2007.
- Curricular materials and dynamic math visualization software of GeoGebra (<http://www.geogebra.org/en/wiki>), adapted to multi-user collaborative learning.
- Training of math teachers and their middle- and high-school students at Drexel and Rutgers.
- The adaptation of conversation analysis to text-based chat interaction analysis, designed to highlight where, how and why collaborative problem solving or group knowledge building takes place

Project Phases and Deliverables

Year I: Focus on in-service teacher professional development. Design, develop and test project technologies, models and resources with this audience, which brings practical teaching experience.

Year II: Focus on pre-service teacher training. Design, develop and test project technologies, models and resources with this audience, which can serve as a new generation with a new model of math education.

Year III: Focus on students in classrooms of trained in- and pre-service teachers. Design, develop and test project technologies, models and resources with this audience, which represents the central target group.

Year IV: Continue to work with in- and pre-service teachers and their students; broaden to include other students. Design, develop and test project technologies, models and resources with students in home-schooling, online-schooling and after-school programs. Adopt approach in several classrooms over longer periods to collect longitudinal data. Encourage informal self-organizing communities of math discourse.

Year V: Focus on dissemination, theory building and evaluation. Publish: curricular resources for interactive math in schools and other settings; teaching models for in- and pre-service math teachers and their students; open source collaboration technologies for virtual math teams and communities, including

multi-user dynamic math shared visualization and exploration tools; best practices and lessons on how and why discourse-based math education can succeed based on strong qualitative research components.

Evaluation

Evaluation is a constant process built into the design of the project. As a design-based research effort, the over-riding research question listed at the start of this project description will be addressed by designing and exploring an iteratively designed solution. The interlocking components of the project will be reviewed at weekly project team meetings. Project personnel who lead a given component will regularly report on progress and raise issues for group discussion. The team meetings will, for instance, include data sessions in which the group collaboratively discusses new data from logs of teachers or students. Design decisions for refining the co-evolving components will also be discussed collaboratively.

The explicit evaluation effort will include semi-annual formative assessment reports documenting: (i) project progress, (ii) improvements in project outcomes and (iii) plans for the next half year. The Advisory Committee will review, discuss and respond to each report. The Advisory Committee will meet at least annually to discuss project progress with the project team.

The Advisory Committee has expertise in mathematics education, research evaluation, teacher training, problem-based learning, conversation analysis, CSCL and virtual communities. The Advisory Committee includes: Sharon Derry (Wisconsin), Cindy Hmelo-Silver (Rutgers-New Brunswick), Tim Koschmann (Southern Illinois), Mary Marlino (UCAR), Kay McClain (Arizona State), Ann Renninger (Swarthmore), Tammy Sumner (Colorado), Dan Suthers (Hawaii). The external evaluator is Jody Underwood.

The project is designed to automatically produce data for formative and summative evaluation in the log files of participant online interactions. The online environment is instrumented to capture all user actions; tools will be developed for automated analysis and visualization of discourse processes. While low-level group processes can be tracked automatically and analyzed statistically, higher-level math-discourse processes have to be interpreted manually—although collaborative-learning coding schemes will be explored during the project.

A primary activity of all participating teachers and students will be to engage in online collaborative problem solving and to reflect on their group accomplishments within the chat environment. The research team will use the logs of these interactions—both the math work and the reflection—to evaluate the quantity and quality of math discourse that takes place, using mixed methods including interaction analysis. By analyzing how, why and for whom the online interaction involves engagement in significant mathematical discourse, researchers will determine what to try in subsequent cycles of design-based research and evaluators will judge project progress.

The focus of evaluation will be on group processes of math cognition, particularly collective methods of math-related visualization, exploration and discourse. Individual learning outcomes will be revealed primarily through analysis of in situ logged discourse—particularly in longitudinal data—rather than through tests, interviews or surveys conducted outside the group settings. Individual learning is essential and integral to collaborative learning, but is here studied as emergent from social processes. (Comparative analysis of outcomes under different approaches and research questions focused on individual outcomes will be left for future projects designed for that.)

Summative evaluation will ensure that milestones for development of resources and publications have been met. Comments of teachers and students—e.g., during their reflections on their logs—will be mined to determine the effectiveness of the support tools for shared visualization and discourse analysis. The evaluation component will assess the degree to which the discourse of teams of teachers or students reveals increased understanding and practice of mathematical cognition.

Dissemination

The primary means of dissemination will be the Math Forum. By the end of the project, the technology and the resources developed through the project will be publicly available as services of the Math Forum. The Math Forum has been the premier online resource for mathematics teaching and learning for over 15 years. In 2009, there were an average of three million visits to the site each month; its digital library contains over a million web pages, mostly user generated (as a leader of the Web 2.0 approach). On-going public services (which typically started from NSF-supported research projects) are supported by Drexel University and by fee-for-service programs and teacher training contracts.

The co-PIs and Advisory Committee members represent several schools of education across the country. The project accomplishments will influence the teacher-training programs in these centers through word of mouth. Teachers who are involved in the in- and pre-service training components of this project will also spread project findings by word of mouth. Ready access to project resources, models and technology at the Math Forum will facilitate such dissemination of innovative math education—including through the popular teacher discussion forums at the Math Forum.

The project technology will all be available as Open Source, so that other researchers and developers can build on it, modify it and install versions on their own servers. (The project technology is built on ConcertChat and GeoGebra, both already available as open source at SourceForge.) Teachers, trainers and researchers who do not have the technical expertise to do this, can simply use the environment that is on the Math Forum servers; they can develop their own curriculum for it and can readily access detailed user logs from it. Support for administration of chat rooms will be built in.

The Math Forum is active in NCTM and will present project findings at the annual conference for teachers of mathematics. Because it provides the first multi-user version of a dynamic mathematics application, the project will be well known within the worldwide communities of GeoGebra and Geometer's Sketchpad users. Finally, project researchers are prominent in the learning science communities around the ICLS and CSCL academic conferences and publish prolifically in academic and practitioner journals, books and conferences.

Expertise

The proposed project brings together an interdisciplinary team of researchers, led by the PIs:

- *PI, Gerry Stahl*: PI on the recently successfully completed VMT Project and several other funded research projects on math education, virtual learning environments, online communities. Author of *Group cognition: Computer support for building collaborative knowledge* and *Studying virtual math teams*, as well as over 150 publications. Founding editor of *International Journal of Computer-Supported Collaborative Learning*. Tenured Associate Professor teaching HCI, CSCL, CSCW, information science, cognitive science, software design at Drexel University.
- *Co-PI, Arthur Powell*: Chair of the Department of Urban Education at Rutgers-Newark and Associate Director of the Robert B. Davis Institute for Learning at Rutgers-New Brunswick. Specializes in problem solving, deductive reasoning and heuristics in math education. Developed masters degree program in Mathematics Learning and Teaching at Drexel.
- *Co-PI, Stephen Weimar*: Director of the Math Forum since 1994. Track record as PI on multiple successful NSF grants.

DR K-12: Computer-Supported Math Cognition Through Shared Visualizations and Collaborative Discourse

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Gerry Stahl teaches, publishes and conducts research in human-computer interaction (HCI) and computer-supported collaborative learning (CSCL). His books are *Group Cognition: Computer Support for Building Collaborative Knowledge* (2006, MIT Press) and *Studying Virtual Math Teams* (2009, Springer). He is founding Executive Editor of the *International Journal of Computer-Supported Collaborative Learning (ijCSCL)*. He is the Principal Investigator of the *Virtual Math Teams Project*, a major research effort in collaboration with the Math Forum@Drexel. He served as Program Chair for the international CSCL '02 conference and Workshops Chair for CSCL '03, '05, '07 and '09. He teaches undergraduate, masters and PhD courses in HCI, CSCW and CSCL.

Professional Preparation

| | | |
|---|--|-----------------|
| Massachusetts Institute of Technology (MIT) | Humanities & Science (Math & Philosophy) | BS 1967 |
| University of Heidelberg | Continental Philosophy | 1967-68 |
| University of Frankfurt | Social Theory | 1971-73 |
| Northwestern University | Philosophy | MA 1971 |
| Northwestern University | Philosophy | PhD 1975 |
| University of Colorado | Computer Science | MS 1990 |
| University of Colorado | Computer Science | PhD 1993 |
| University of Colorado | Computer Science & Cognitive Science | Postdoc 1996-99 |

Appointments & Professional Experience

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|--------------|---|
| 2002-present | Associate Professor (Tenured May 2008) College of Information Science & Technology Drexel University, Philadelphia, PA |
| 2001-2002 | Visiting Research Scientist BSCW Development Team, CSCW Department, FIT GMD and Fraunhofer Institutes, Bonn, Germany |
| 1999-2001 | Assistant Research Professor Department of Computer Science & Institute of Cognitive Science University of Colorado, Boulder, CO |
| 1996-1999 | Post Doctoral Research Fellow Center for LifeLong Learning and Design University of Colorado, Boulder, CO |
| 1993-1996 | Director of Software R&D Owen Research Inc., Boulder, CO |

Relevant Publications

- Stahl, G. (2009). *Studying virtual math teams*. New York, NY: Springer.
- Stahl, G. (2006). *Group cognition: Computer support for building collaborative knowledge*. MIT Press.
- Stahl, G. (2008). Book review: Exploring thinking as communicating in CSCL. *International Journal of Computer-Supported Collaborative Learning*, 3(3), 361-368.
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- Stahl, G. (2009). Group cognition as a foundation for the new science of learning. In M. S. Khine & I. M. Saleh (Eds.), *New science of learning: Computers, cognition and collaboration in education*. Springer.

Other Publications

- Stahl, G. (2009). *Collaborative learning through practices of group cognition*. Paper presented at the international conference on Computer Support for Collaborative Learning (CSCL 2009), Rhodes, Greece.

- Stahl, G. & Hesse, F. (2006). Inaugural issue. *International Journal of Computer-Supported Collaborative Learning (ijCSCL)*, 1 (1). Available online at <http://ijCSCL.org>.
- Stahl, G. (Ed.). (2002). *Computer support for collaborative learning: Foundations for a CSCL community*. Proceedings of CSCL 2002. January 7-11. Boulder, Colorado, USA. Hillsdale, NJ: Lawrence Erlbaum.
- Stahl, G. (2005). *Groups, group cognition & groupware [keynote]*. Paper presented at the International Workshop on Groupware (CRIWG 2005), Racife, Brazil.
- Stahl, G. (2003). *The future of computer support for learning: An American/German DeLFIc vision [keynote]*. Paper presented at the First Conference on e-Learning of the German Computer Science Society (DeLFI 2003), Munich, Germany. Proceedings pp. 13-16.

Synergistic Activities

- 2009-2012: “*Dynamic Support for Virtual Math Teams.*” (PI with co-PI Stephen Weimar; collaborative with Carolyn Rosé) \$306,355; sponsor: NSF ALT. Award DRL-0835383.
- 2007-2008: “*Exploring Adaptive Support for Virtual Math Teams.*” (co-PI with PI Carolyn Rose) \$50,000; sponsor: NSF SGER. Award DRL-0723580.
- 2005-2007: “*SoL Catalyst: Engaged Learning in Online Communities.*” (PI with co_PIs Sharon Derry, Mary Marlino, K. Ann Renninger, Daniel Suthers, Stephen Weimar) \$180,762; sponsor: NSF SOL. Award SBE-0518477.
- 2003-2009: “*IERI: Catalyzing & Nurturing Online Workgroups to Power Virtual Learning Communities.*” (PI with co-PIs Stephen Weimar and Wesley Shumar) \$2,300,000; sponsor: NSF IERI.
- 2003-2005: “*Collaboration Services for the Math Forum Digital Library*” (PI with co-PIs Stephen Weimar and Wesley Shumar) \$450,000; sponsor: NSF NSDL. Award IERI-0325447.
- 1997-2000: “*Allowing Learners to be Articulate: Incorporating Automated Text Evaluation into Collaborative Software Environments*” (primary author and primary software developer; PIs: Gerhard Fischer, Walter Kintsch and Thomas Landauer) \$678,239; sponsor: James S. McDonnell Foundation.
- 1997-2000: “*Conceptual Frameworks and Computational Support for Organizational Memories and Organizational Learning*” (co-PI with Gerhard Fischer and Jonathan Ostwald), \$725,000; sponsor: NSF.
- 1998-1999: “*Collaborative Web-Based Tools for Learning to Integrate Scientific Results into Social Policy*” (co-PI with Ray Habermann) \$89,338; sponsor: NSF.

Collaborators & Other Affiliations

Scientific Advisory Boards: Knowledge Media Research Center (KMRC, Germany), Learning Sciences Laboratory (LSL, NIE, Singapore), Knowledge Practices Laboratory (K-P Lab, Finland).

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Sean Goggins teaches, publishes and conducts research in the uptake and use of information and communication technologies by distributed teams of students and workers. Dr. Goggins' research interests are centered on socio-technical systems and theory to support physically distributed small group collaboration and creativity. He pursues this agenda through design based research methods, quantitative analysis of joint performance outcomes among small groups and deep ethnographic studies of small online group formation and development. Dr. Goggins obtained his graduate education while working in technology leadership positions in the utility, software, medical device and publishing industries.

Professional Preparation

| | | |
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| University of Wisconsin Madison | History | BS 1989 |
| University of Wisconsin Milwaukee | Human Resource Development | MS 1990 |
| University of Minnesota Twin Cities | Software Engineering (Computer Science) | MS 2003 |
| University of Missouri Columbia | Information Science and Learning Technology | PhD 2009 |

Appointments & Professional Experience

- 2009-present **Assistant Professor**
 College of Information Science & Technology
 Drexel University, Philadelphia, PA
- 2009 **Teaching Assistant**
 University of Missouri
- 2005-2008 **Director of Product Development**
 Foliotek
 Columbia, MO
- 2004-2005 **Software Architect**
 MDConsult / Elsevier, St. Louis, MO
- 2003-2004 **Software Architect**
 Nestle Purina, St. Louis, MO
- 1999-2003 **Enterprise Architect**
 Guidant Corporation, St. Paul, MN

Relevant Publications

Tsai, I.-C., Kim, B., Goggins, S., Kumalasari, C., Laffey, J., & Amelung, C. (2008). "A Model Explaining the Social Nature of Online Learning," *Journal of Educational Technology and Society*.

Laffey, J., Amelung, C., & Goggins, S. (2008). "A Context Awareness System for Online Learning: Design Based Research," *International Journal on E-Learning*.

Schmidt, M., Goggins, S., & Laffey, J. (2008). "The Design of iSocial," *International Journal of Technology, Knowledge and Society*.

Goggins, S., Laffey, J., & Tsai, I.-C. (2007). "Cooperation and Groupness: Community Formation in Small online Collaborative Groups," *Paper presented at the ACM Group, 2007, Sanibel Island, FL*.

Goggins, S., Laffey, J., & Galyen, K. (2009). *Social Ability in Online Groups: Representing the Quality of Interactions in Social Computing Environments*. Paper presented at the IEEE Social Computing Conference, Vancouver, BC.

Other Publications

Goggins, S., & Erdelez, S. (2009). *HIB and HCI: Common Interests in Different Communities*. Paper presented at the iConference, 2009, Chapel Hill, NC.

Goggins, S., & Erdelez, S. (2009). Collaborative Information Behavior in Completely Online Groups. In J. Foster (Ed.), *Collaborative Information Behavior: User Engagement and Communication Sharing*. Hershey, PA: ISI Global.

Goggins, S., Floyd, I., Sawyer, S., Grudin, J., Dabbish, L., Erickson, I. et al. (2009). The Science of Socio-Technical Systems in iSchools. *iConference, 2009*.

Stichter, J., Schmidt, C., Schmidt, M., Goggins, S., Babuich, R., & Laffey, J. (2009). *iSocial: A 3-D Virtual Learning Environment for Enhanced Social Interaction and Development of Social Competence*. Poster presented at the CSCL, 2009, Rhodes, Greece.

Goggins, S., Tsai, I.-C., Kim, B., Kumalasari, C., Laffey, J., & Amelung, C. (2007). "Building a Model Explaining the Social Nature of Online Learning," *Paper presented at the American Education Research Association, 2007, Chicago, IL*.

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Michael Khoo studies the complex social and technical dimensions of digital library use, with a focus on understanding the different mental models and practices that users bring to their interactions with these systems. He has worked extensively on the formative and summative evaluation of STEM digital libraries since 2000. Evaluation sites have included the Digital Water Education Library (DWEL), the Digital Library for Earth Systems Education (DLESE), and the National Science Digital Library (NSDL), all funded by the NSF. This work has included the development of a general logic model for designing digital library evaluation initiatives that is suitable for application across a wide variety of digital libraries. He draws on models of culture, practice and knowledge, from anthropology, communication, user-centered design, and science, technology and society (STS) studies, and operationalizes these with a range of methods, including ethnography, webmetrics, user-centered design, interviews, surveys and focus groups, and analyses of organizational communication.

Professional Preparation

| | | |
|---|------------------------------|------------------|
| Bulmershe College, Reading University, U.K. | Regional Development Studies | BA (Hons) 1983 |
| University of London School of Advanced Study, U.K. | Area Studies | MA 1984 |
| University of Colorado | Anthropology | MA 2000 |
| University of Colorado | Communication | PhD 2004 |
| National Center for Atmospheric Research | Advanced Study Program | Post-doc 2004-05 |

Appointments & Professional Experience

2007 - present Assistant Professor, College of Information Science & Technology
Drexel University, Philadelphia, PA

2005 - 2007 Evaluation Coordinator, National Science Digital Library (NSDL)
Boulder, Colorado, USA

Relevant Publications

Khoo, M., & S. Giersch. (2009). Planning an Evaluation Initiative. In: Papatheodorou, C., & G. Tsakonas (Eds.), *Evaluating Digital Libraries*, Oxford, U.K.: Chandos Publishing House.

Khoo, M., J. Pagano, A. Washington, M. Recker, B. Palmer, & R. Donahue (2008). *Using Web Metrics to Analyze Digital Libraries*. Joint Conference on Digital Libraries (JCDL), Pittsburgh, PA, June 16-20, 2008. Pp. 375-384.

Khoo, M. (2007). Guest editor, New Review of Hypermedia and Multimedia, *Studying the Users of Digital Educational Technologies*, Vol. 13(2).

Khoo, M. (2006). *A Sociotechnical Framework for Digital Library Evaluation*. Procs. Annual Meeting of the American Society for Information Science and Technology (ASIST), Austin, TX, November 3-6, 2006.

Khoo, M. (2005). *The Tacit Dimensions of User Behavior: The Case of the Digital Water Education Library*. Joint Conference on Digital Libraries (JCDL), Denver, CO, June 7-11, 2005. Pp. 213-222.

Other Publications

Khoo, M., D. McArthur, & L. Zia (2009). Evaluating Impact: An Agency Perspective. Papatheodorou, C., & G. Tsakonas (Eds.), *Evaluating Digital Libraries*, Oxford, U.K.: Chandos Publishing House.

Khoo, M., X. Lin, & J. Park (2009). *A User-Friendly Metadata Quality Control Tool for the Internet Public Library*. 9th ACM/IEEE Joint Conference on Digital Libraries (JCDL), Austin, TX, June 15-19, 2009, pp. 407-408.

Khoo, M. (2004). *The Use of Visual Artifacts in the User-Centred Design of Educational Digital Libraries*. Journal of Digital Information, Volume 5, Issue 3.

Sumner, T., M. Khoo, and M. Recker. (2003). *Understanding Educator Perceptions of "Quality" in Digital Libraries*. Joint Conference on Digital Libraries (JCDL), Houston, TX, May 27-31, 2003.

Khoo, M. (2001). *Ethnography, Evaluation, and Design as Integrated Strategies: A Case Study from WES*. European Conference on Digital Libraries (ECDL), Darmstadt, Germany, September 4-8, 2001. Pp. 263-274.

Synergistic Activities

- 2008: OCLC Library and Information Science Research Grant Program: “Addressing the “metadata bottleneck” by developing and evaluating an online tool to support non-specialists to evaluate dublin core metadata records.” \$14,855.
- 2008-present: Program committee member, European Conference on Digital Libraries (ECDL)
- 2008-present: Reviewer, Journal of the American Society for Information Science and Technology (JASIST)
- 2005-present: Program committee member, ACM/IEEE Joint Conference on Digital Libraries (JCDL)

Collaborators – past 48 months

| | |
|---------------------------|---|
| Jean-Françoise Blanchette | UCLA, USA |
| Geof Bowker | Santa Clara University, USA |
| George Buchanan | Center for HCI Design, City University, London, UK |
| Sally Jo Cunningham | Dept. Computer Science, Waikato University, New Zealand |
| Robert Donahue | Teachers’ Domain Digital Library, WGBH, Boston, USA |
| Luis Francisco-Revilla | University of Texas – Austin, USA |
| Gary Geisler | University of Texas – Austin, USA |
| David Germano | Dept. Religious Studies, University of Virginia, USA |
| Sarah Giersch | Center for Digital Research and Scholarship, Columbia University, USA |
| Xia Lin | The iSchool, Drexel University, USA |
| Rebecca Menendez | Autry Museum, Los Angeles, USA |
| David MacArthur | School of Education, University of North Carolina, USA |
| Joe Pagano | The Library of Congress, USA |
| Bart Palmer | Utah State University, USA |
| Jung-ran Park | The iSchool, Drexel University, USA |
| Mimi Recker | Utah State University, USA |
| Anne Washington | The Library of Congress, USA |
| Lynn Westbrook | University of Texas – Austin, USA |
| Lee Zia | Division of Undergraduate Education, National Science Foundation, USA |

Graduate Advisors

Michele H. Jackson, Dept. Communication, University of Colorado-Boulder
Tamara (‘Tammy’) Sumner, Depts. Cognitive and Computer Science, University of Colorado-Boulder

Thesis Advisor and Postgraduate-Scholar Sponsor

None.

Dr. Jason Silverman
Assistant Professor, Drexel University School of Education
3141 Chestnut Street Philadelphia, PA 19104
silverman@drexel.edu

A. PROFESSIONAL PREPARATION

| | | |
|-----------------------------|-----------------------|-------------|
| Franklin & Marshall College | Mathematics | B.A., 1996 |
| Vanderbilt University | Mathematics Education | M.S., 2004 |
| | Mathematics | M.S., 2005 |
| | Mathematics Education | Ph.D., 2005 |

B. APPOINTMENTS

Assistant Professor of Mathematics Education, Drexel University (2006 – present)
Research Associate, The Math Forum @ Drexel (2006 – present)
Adjunct Assistant Professor of Mathematics, Nashville State Community College (2000-2005)
Instructor of Mathematics and Physics, The Hill School (1996-2000)

C. PUBLICATIONS

Related Publications

Silverman, J. and Clay, E.(in press). *Examining Mathematics Teacher Education: Online Asynchronous Collaboration and the Development of Mathematical Knowledge for Teaching*. The Teacher Educator.

Clay, E. & Silverman, J. (2009). Reclaiming lost opportunities: The role of the teacher in online asynchronous collaboration in mathematics teacher education. In C. Maddux (Ed.) *Research Highlights in Information Technology and Teacher Education 2009*. Chesapeake, VA: Society for Information Technology and Teacher Education (SITE).

Silverman, J., & Thompson, P.W. (2008). Toward a Framework for the Development of Mathematics Content Knowledge for Teaching. *Journal for Mathematics Teacher Education*, 11(6), 499-511.

Silverman, J. & E. Clay (2008). *Online Asynchronous Collaboration in Mathematics Teacher Education*. Proceedings of the Annual Meeting of the Society for Information Technology in Teacher Education, March 3-7, 2008. Las Vegas, Nevada: SITE.

Thompson, P.W., Carlson, M. and Silverman, J. (2007). The design of tasks in support of teachers' development of coherent mathematical meanings. *Journal of Mathematics Teacher Education*, 10, 415-432. (Special double issue on the role of tasks in mathematics teacher education)

Other Publications

Silverman, J. (2006). *A focus on Quantities of Variable Measure in Covariational Reasoning*. Proceedings of the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, November 9 – 12, 2006. Merida, Mexico

D. SYNERGISTIC ACTIVITIES

Current Professional and Academic Association Membership

- National Council of Teachers of Mathematics (NCTM)
- Psychology of Mathematics Education, North American Chapter (PME-NA)
- International Group for the Psychology of Mathematics Education (PME)
- American Educational Research Association (AERA)
- Special Interest Group for Research in Mathematics Education (SIG-RME)
- Association of Mathematics Teacher Educators

Research Interests

Mathematics teacher education; Teaching and learning of calculus; Mathematical knowledge for conceptual teaching; research in undergraduate mathematics education; mathematics for secondary teachers; technology in mathematics education

Other Activities

- Developed masters degree program in Mathematics Learning and Teaching at Drexel.
- In 2004-2005 PI Silverman worked on a two-semester contract on The Case Files, an NSF/DUE grant (DUE-0202397). He served as a co-developer of a problem-based case and an instructor in an experimental section of college algebra. The case study focused on students' understandings of linear functions and rate of change linear relations, a precursor to derivatives and calculus.
- Student Teaching Mentor and Practicum Supervisor (Secondary Mathematics Education)
- Journal Reviewer: Journal for Research in Mathematics Education; Journal for Research in Mathematics Teacher Education.
- Proposal Reviewer and Discussant: North American Chapter of the International Group for the Psychology of Mathematics Education (2003-present); Proposal Reviewer: American Educational Research Association (2004-present)
- Graduate Student Member of Secondary Education Committee at Vanderbilt University

E. COLLABORATORS AND OTHER AFFILIATIONS

Collaborators

Patrick Thompson, Arizona State University; Kay McClain, Arizona State University; Chrystal Dean, Clemson University; Steve Weimar, Drexel University; Wesley Shumar, Drexel University; K. Ann Renninger, Swarthmore College; Gene Klotz, Swarthmore College.

Graduate Advisors

Patrick Thompson, Arizona State University

Stephen Andrew Weimar
Director, The Math Forum

APPOINTMENTS

Director, The Math Forum @ Drexel, Drexel University (2001-present): Responsible for research and business development, operations, and program design of this leading application of the Internet to improve mathematics education.

Vice President, Learning Partnerships, WebCT (2000-2001): Led the development of the online academic communities and consulting services to form an effective business unit driving the successful implementation of WebCT for higher education, K-12, and corporate clients.

Co-Principal Investigator and Project Director, Geometry Forum, Math Forum, Swarthmore College (1994–2000): Coordinate project development for this Internet-based electronic community and NSF-sponsored research project in math education and telecommunications.

Education Consultant (1988–1994): Freelance consultant to schools, colleges, and educational organizations for teacher professional development.

Executive Director, Philadelphia Chapter of Educators for Social Responsibility (ESR) (1983–1988): Established and administered this professional organization for public, private, and parochial school teachers in the Philadelphia area.

Math Teacher, Germantown Friends School, Philadelphia (1980–1983): Middle and high school mathematics.

PUBLICATIONS

Weimar, S. A., et. al. (1993-present). *The Math Forum* <http://mathforum.org/>

Shumar, W., Renninger, K. A., & Weimar, S. A. (in press). Communities, texts, and consciousness: The practice of participation at The Math Forum. In J. Falk and B. Drayton (Eds.). *What have we learned about electronic communities for professional development?* NY, Teachers College Press.

Wessner, M., Shumar, W., Stahl, G., Sarmiento, J., Muehlfordt, M., & Weimar, S. (2006). *Designing an online service for a Math community*. Paper presented at the International Conference of the Learning Sciences (ICLS 2006), Bloomington, IN. <<http://www.cis.drexel.edu/faculty/gerry/pub/icls2006design.pdf>>

Renninger, K. A., Stahl, G., Suthers, D., Marlino, M., Weimar, S., Derry, S., et al. (2006). *Studying engaged learning in online communities [workshop]*. Paper presented at the International Conference of the Learning Sciences (ICLS 2006), Bloomington, IN. <<http://www.cis.drexel.edu/faculty/gerry/pub/icls2006eloc.pdf>>

Computing Research Association (2005), *Cyberinfrastructure for Education and Learning for the Future:: A Vision and Research Agenda*. <<http://www.cra.org/reports/cyberinfrastructure.pdf>>

Giersch, S., Klotz, E. A., McMartin, F., Muramatsu, B., Renninger, K. A., Shumar, W., et al. (2004, July/August). If you build it, will they come? Participant involvement in digital libraries. *D-Lib Magazine*, 10(7/8). Retrieve from <http://www.dlib.org/dlib/july04/giersch/07giersch.html>

SYNERGISTIC ACTIVITIES

Co-PI, *The Math Forum's Virtual Fieldwork Sequence*. September '07 – '09. NSF CCLI. Developing and researching teacher education components for mathematics content knowledge, learning diagnostics, and instructional strategies, built around online student problem-solving programs.

Co-PI, *Virtual Math Teams*, September '03-'09. NSF ITR. A collaboration with Gerry Stahl in the Drexel College of Information Science and Technology investigating effective environments for online mathematics problem-solving in groups.

Co-PI, *Leadership Development for Technology Integration*. October '05-'08. NSF DUE (NSDL). Developing a workshop-based teacher leadership program for integrating NSDL resources into the classroom.

Co-PI, *Engaged Learning in Online Communities*. October '05-'07. NSF Science of Learning Centers. Developing a research agenda concerning learning in informal online education communities.

Co-PI, *Project K-Nect*, June '07-'08, a collaboration with Digital Millennial Consulting, funded by Qualcomm, that developed a problem solving and social networking environment on Smartphones for low-performing Algebra I students in North Carolina. Classes in the project outperformed control groups after one semester by 10-20% in both course grades and state assessments.

COLLABORATORS & OTHER AFFILIATIONS

Agogino, Alice, U. Cal. Berkeley
Albers, Donald, Math. Assoc. of America
Char, Bruce, Drexel University
Chung, Mark, SRI
Croft, Bruce, UMass
Cuoco, Al, EDC
Derry, Sharon, University of Wisconsin
DiGiano, Christopher J., SRI
Duffin, Joel, Utah State
Falk, John, Institute for Learning Innovation
Goldenberg, Paul, EDC
Heal, Robert, Utah State
Hewett, Thomas, Drexel University
Hoadley, Chris, Penn State
Johnson, Jeremy, Drexel University
King, Jim, Washington
Krandick, Werner, Drexel University
Loken, Eric, Penn State
Marlino, Mary, DLESE

Merlino, Joe, LaSalle College
Moore, Lang, Duke University
Panoff, Robert, Shodor
Reese, George, University of Illinois, Urbana-Champaign
Renninger, K. Ann, Swarthmore College
Repenning, Alex, University of Colorado, Boulder
Roschelle, Jeremy, SRI
Shechtman, Nikki, SRI
Shumar, Wesley, Drexel University
Simutis, Len (Eisenhower National Clearinghouse)
Stahl, Gerry, Drexel University
Suthers, Daniel, University of Hawaii
Underwood, Jody, ETS
Webb, Norman L., U. of Wisconsin
Wood, Bill, U. of Maryland
Woolf, Beverly, University of Massachusetts

Annie Fetter

The Math Forum @ Drexel
3210 Cherry Street, Philadelphia PA 19104
annie@mathforum.org

Education

BA, Swarthmore College, 1988, Mathematics and Music, and Pennsylvania Secondary Mathematics Teaching Certification.

Professional Experience

1995-Present: Problem of the Week Supervisor and Professional Development Specialist, The Math Forum Primary responsibilities include running the student projects that the Math Forum sponsors, including our Problem of the Week projects, and designing and running professional development activities for teaching professionals. This currently includes professional development and in-class support for teachers in three School District of Philadelphia elementary schools around the implementation of the *Everyday Math* curriculum, as well as work with middle schools teachers in Camden County, New Jersey, focused on technology implementation in inclusion classrooms. I also support teachers in Drexel's Transition to Teaching program and TA a course in the program.

1995-Present: Educational Consultant and Editor I work as a consultant for Key Curriculum Press teaching beginning and advanced *Geometer's Sketchpad* workshops. This included co-leading weeklong institutes for teaching professionals during the summer, for which I planned the agenda and wrote and selected the activities that were used. Privately I do custom *Sketchpad* workshops for schools and districts. I have also worked as a technical editor for Key, most recently editing and producing the graphics for *Exploring Calculus with The Geometer's Sketchpad*.

1992-1995: Project Coordinator, The Geometry Forum The Geometry Forum preceded the Math Forum as the group's first online math project. I was the sole full-time employee for much of the project, and was responsible for everything from organizing workshops for teachers to assisting users via email and phone, as well as working closely with students participating in online projects.

1988-1992: Administrative Assistant, The Visual Geometry Project Responsibilities included writing, editing, and layout and design for workbooks about three-dimensional geometry designed for use by high school geometry students, high quality 3/4" video production, and supervision of a testing program involving middle and high school teachers from across the country. The project also produced the first version of *The Geometer's Sketchpad*.

Presentations

From 1993 to the present, I have taught at, presented at, written curriculum for, and organized numerous workshops run by the Geometry Forum, the Math Forum, and Key Curriculum Press. Recent highlights include:

Camden County INCLUDE Grant, providing professional development and mentoring/modeling, supporting middle school teachers incorporating technology in inclusion classrooms, 2007-2009.

Temple University Partnership Summer Lab School, providing professional development for K-8 teachers and in-class support for K-3 teachers focused around measurement activities and how to learn more about what students already know through accountable talk and questioning, 2008.

Speaker, NCSM and/or NCTM Annual Meetings, 1998-2009.

Formal Publications

Problems of the Week Engage Students with Special Needs, ENC's Focus, Volume 10, Number 2

Three sets of materials co-authored by Dr. Doris Schattschneider and Cindy Schmalzried:

The Stella Octangula, computer-animated videotape and workbook, Key Curriculum Press, 1991

The Platonic Solids, videotape and workbook, Key Curriculum Press, 1991

Three Dimensional Symmetry, videotape and workbook, Key Curriculum Press, 1995

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|---------------------|--|---|
| Andrea Forte | College of Information Science and Technology Drexel University Philadelphia, PA 19104 | aforte@gatech.edu http://www.andreaforte.net |
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Professional Preparation

| | | |
|---------------------------------|---|-----------|
| University of Passau, Germany | Literature | 1994-1995 |
| Western Michigan University | Foreign Language and Literature/ Philosophy | BA 1996 |
| University of Texas at Austin | Library and Information Science | MLIS 1998 |
| Georgia Institute of Technology | Human-Centered Computing | PhD 2009 |

Appointments & Professional Experience

Beginning 2010 **Assistant Professor**
College of Information Science & Technology
Drexel University, Philadelphia, PA

Relevant Publications

- Forte, Andrea and Amy Bruckman. (submitted) "Writing, citing, and participatory media: wikis as learning environments in the high school classroom." *International Journal of Learning and Media*. Under review.
- Forte, Andrea and Amy Bruckman. (2007) "Constructing text: wiki as a toolkit for (collaborative?) learning." *Proceedings of International Symposium on Wikis (WikiSym)*, Montréal, Canada, pp 31-42.
- Forte, Andrea and Amy Bruckman. (2006) "From Wikipedia to the classroom: exploring online publication and learning." *Proceedings of the International Conference of the Learning Sciences*, Bloomington, IN.
- Peters, V., Slotta, J., Forte, A., Bruckman, A., Lee, J., Gaydos, M., Hoadley, C., Clarke, J. (2008). "Learning and Research in the Web 2 Era: New Opportunities for Research" Refereed symposium. *Proceedings of the International Conference of the Learning Sciences*, Utrecht, NL, June 2008.

Other Publications

- Forte, Andrea, Vanessa Larco and Amy Bruckman. (2009) "Decentralization in Wikipedia governance" *Journal of Management Information Systems*. 26(1) pp 49-72.
- Bruckman, Amy, Alisa Bandlow and Andrea Forte. (2007). "HCI For kids." In *The Human-Computer Interaction Handbook*. Edited by Julie Jacko and Andrew Sears, 2nd Ed. NJ: Lawrence Erlbaum Associates.
- Bryant, Susan, Andrea Forte and Amy Bruckman. (2005) "Becoming Wikipedian: transformation of participation in a collaborative online encyclopedia" *Proceedings of GROUP: International Conference on Supporting Group Work*, Sanibel Island, FL. pp 1-10.
- Forte, Andrea and Mark Guzdial. (2005) "Motivation and non-majors in CS1: Identifying discrete audiences for introductory computer science." *IEEE Transactions on Education*, 48(2) pp 248-253.
- Forte, Andrea and Mark Guzdial. (2004) "Computers for communication, not calculation: media as a motivation and context for learning." *Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04)*, Big Island, HI.

Collaborators & Other Affiliations

Collaborators and Co-Authors: Amy Bruckman, Mark Guzdial (GVU Center, Georgia Institute of Technology), Vanessa Peters, James Slotta (Ontario Institute for Studies in Education, University of Toronto), Joey Lee (Teacher's College, Columbia University), Jody Clark (Harvard Graduate School of Education), Chris Hoadley (Pennsylvania State University), Matthew Gaydos (University of Wisconsin Madison)

Dissertation Advisors: Amy Bruckman, Mark Guzdial, Janet Kolodner, Rebecca Grinter (Georgia Institute of Technology), Jonathan Grudin (Microsoft Research)

Students Co-advised: Susan Bryant, Amruta Lonkar, Jordan Patton (MS Students), Vigneshwar Kalyanasundaram, Anne Hewitt, Alex Dodson, Scott Ehardt, Christopher Jordan, Vanessa Larco, Achille Brighton, Kevin Zeigler, Heather Chang (BS Students)

| | | |
|----------------------|---|-----------------------------------|
| Ian Underwood | Math Forum Drexel University Philadelphia, PA 19104 | 215-801-3128 ian@mathforum.org |
|----------------------|---|-----------------------------------|

Ian Underwood runs the Ask Dr. Math service for the Math Forum @ Drexel University.

Professional Preparation

| | | |
|-------------------------|---------------------------|---------|
| Purdue University | Math and Computer Science | BS 1983 |
| Northwestern University | Learning Sciences | MS 1992 |

Appointments & Professional Experience

| | |
|--------------|---|
| 2000-present | Director, Ask Dr. Math Math Forum Drexel University, Philadelphia, PA |
| 1996-2000 | Senior Scientist Expert-Ease, Ltd Jerusalem, Israel |
| 1994-1996 | Lead Developer Bar-On, Ltd Haifa, Israel |
| 1992-1994 | Member of Technical Staff Artificial Intelligence Branch NASA Ames Research Center, Mountain View, CA |
| 1983-1990 | Member of Technical Staff Navigation Ancillary Information Facility NASA JPL Research Center, Pasadena, CA |

| | | |
|-------------------------------|---|--|
| Baba Kofi A. Weusijana | The Math Forum Drexel University 3210 Cherry Street Philadelphia, PA 19104 | 215-895-1080 (The Math Forum) 215-895- 2964 (fax) baba@mathforum.org http://edutek.net/kofi |
|-------------------------------|---|--|

Baba Kofi A. Weusijana is a learning scientist researching and developing advanced technologies for informal and formal learning. He is the Lead Software Engineer of the *Virtual Math Teams Project*, a major research effort in collaboration with the Math Forum at Drexel University.

Dr. Weusijana's academic interests include Internet educational software, Computer Supported Collaborative Learning (CSCL), informal and formal learning with Multi-User Virtual Environments (MUVEs), effective teaching strategies for web-based tutoring software, distance education, computer modeling of traditional African social environments, home schooling, metacognitive reflection, fostering learner engagement, and educational access.

Professional Preparation

| | | |
|----------------------------|--|-------------------|
| Foothill Community College | Computer Science | AS 1990 |
| Dillard University | Mathematics | BS 1992 |
| San José State University | Computer Science (African Studies Minor) | BS 1997 |
| San José State University | General Engineering (Client/Server Computing with Distributed Objects Concentration) | MS 1999 |
| Northwestern University | Learning Sciences | PhD 2006 |
| University of Washington | Learning in Informal and Formal Environments (LIFE) Science of Learning Center (SLC) | Postdoc 2005-2008 |

Appointments & Professional Experience

| | |
|--------------|---|
| 2009-present | Software Engineer & Researcher Virtual Math Teams (VMT), The Math Forum Drexel University, Philadelphia, PA |
| 2008-2009 | Associate Faculty Cascadia Community College, Bothell, WA |
| 2005-2008 | Research Associate Faculty NSF LIFE Science of Learning Center, University of Washington, Seattle, WA |
| Summer 2005 | Technical Co-op Intern Adaptive Simulations Adventurous Research Project IBM T. J. Watson Research Center, Yorktown Heights, NY |
| 2003-2005 | Consultant Academic Technologies Northwestern University, Evanston, IL |
| 2001-2005 | Graduate Assistant NSF VaNTH Engineering Research Center for Bioengineering Educational Technologies Northwestern University, Evanston, IL |
| 2001 | Software Engineer Center for Connected Learning and Complex Modeling (CCL) Northwestern University, Evanston, IL |
| 1998-1999 | Software Engineer AvantSoft Corporation Sunnyvale, CA |

Relevant Publications

Weusijana, B. K. A., Kumar, R., & Rosé, C. P. (2008). *MultiTalker: Building Conversational Agents in Second Life using Basilica*. Paper presented at the Second Life Education Community Convention, Purple Strand: Educational Tools and Products, Tampa, FL. <http://www.edutek.net/Kofi/WeusijanaKumarRose2008.pdf> (accessed September 21, 2009)

Other Publications

- Weusijana, B., V. Svihla, D. Gawel, and J. Bransford. (2009). MUVes and Experiential Learning: Some Examples. *Innovate* 5 (5). <http://www.innovateonline.info/index.php?view=article&id=702>
- Weusijana, B. K. A., Gawel, D. J., Svihla, V., & Bransford, J. D. (2007). *Learning about Adaptive Expertise in a Multi-User Virtual Environment*. Paper presented at the Second Life Community Convention, Education Track, Chicago, IL. <http://www.simteach.com/slccedu07proceedings.pdf> (accessed December 24, 2008) Archived at <http://www.webcitation.org/5dJnmYZKs>.
- Mead, P. F., Stephens, R., Richey, M., Bransford, J. D., & Weusijana, B. K. A. (2007). *A Test of Leadership: Charting Engineering Education for 2020 and Beyond*. Paper presented at the 48th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Honolulu, Hawaii.
- Weusijana, Baba Kofi A. (2006). *A Socratic ASK System: Helping Educators Provide a Web-Based Socratic Tutor for Learners*. Northwestern University, Evanston, IL. <http://www.lib.umi.com/dissertations/fullcit/3238417>
- Riesbeck, Christopher K., Lin Qiu, Baba Kofi Weusijana, Joseph T. Walsh, Matthew Parsek (2003) *Learning Technologies to Foster Critical Reasoning: Focusing on Challenge-Based Learning Activities That Are Effective for Long-Term Learning*, IEEE Engineering in Medicine and Biology Society, New York, NY. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1237502

Synergistic Activities

- Co-faculty with Dr. Sashank Varma, NSF LIFE SLC Brown Bag Series, Spring 2007, University of Washington and Stanford University
- Co-faculty with Dr. Sashank Varma, NSF LIFE SLC Theory Seminar, Fall 2006 & Winter 2007 quarters, University of Washington and Stanford University
- Conference Reviewer, American Educational Research Association Annual Meeting, Special Interest Group on Technology as an Agent for Change in Teaching and Learning, 2004
- Co-coordinator, Learning Sciences Program Research Brown Bag Seminars, Northwestern University, 2001-2002
- Students' Representative, Chief Information Officer Advisory Committee, San Jose State University, 1997
- Student Senator, Faculty Academic Senate, San Jose State University, 1996-1997

Collaborators & Other Affiliations

Collaborators: Gerry Stahl, Steve Weimar, George Mathew, Murat Çakir, Xiantong “Jimmy” Ou, (Drexel University, Philadelphia); Carolyn Rosé, Rohit Kumar (CMU, Pittsburgh), John D. Bransford, Drue Gawel, Susan Mosborg, Nancy Vye (University of Washington, Seattle); Vanessa Svihla (University of Texas at Austin); Patricia Mead, Lauren Thomas (Norfolk State University); Ugochi Cynthia Acholonu (Stanford University); John Brecht, Patricia Mead, Nora Sabelli (SRI International, Menlo Park); Cavallo, David, Shaundra Bryant Daily, (MIT, Cambridge); Wanda Eugene (Auburn University); Mark Kevin Singley, Peter Fairweather, Richard Lam, Jennifer Lai (IBM Watson Research Center, Yorktown Heights); Christopher Riesbeck, Allan Collins, Daniel Edelson, Ann McKenna, Lin Qiu, Brian Reiser, H. David Smith, Joseph T. Walsh Jr., and Bugrahan Yalvac (Northwestern University, Evanston); Larry Howard (Vanderbilt University, Nashville)

Dissertation Advisors: Christopher K. Riesbeck, Allan M. Collins, Daniel C. Edelson, Brian J. Reiser. (Northwestern University, Evanston)

| | | |
|-------------------|--|---|
| Alan Zemel | College of Arts and Sciences Department of Culture & Communication Drexel University Philadelphia, PA 19104 | 215-895-6146 (office) 215-895-1333 (fax) arz26@drexel.edu |
|-------------------|--|---|

Alan Zemel teaches, publishes and conducts research in computer-mediated communication (CMC) and computer-supported collaborative learning (CSCL).

Professional Preparation

| | | |
|---|---|-----------------|
| University of Pennsylvania | Regional Science Economics | BA 1976 |
| University of Pennsylvania | Regional Science | MA 1976 |
| Temple University | Rhetoric and Communication | PhD 2002 |
| Southern Illinois University School of Medicine | Medical Education | Postdoc 2002-04 |
| Drexel University | College of Information Science & Technology | Postdoc 2004-06 |

Appointments & Professional Experience

| | |
|--------------|---|
| 2006-present | Associate Teaching Professor Department of Culture and Communication College of Arts and Sciences Drexel University, Philadelphia, PA |
| 2004-2006 | Research Manager College of Information Science & Technology Drexel University, Philadelphia, PA |
| 2002-2004 | Post Doctoral Research Fellow Department of Medical Education Southern Illinois University School of Medicine, Springfield, IL |
| 2000-2002 | Instructor Department of Communication Science Department of Speech Communication Temple University, Philadelphia, PA |
| 2000-2002 | Instructor Department of Communication Ursinus College, Collegeville, PA |

Relevant Publications

- Zemel, A. & Cakir, M. (Forthcoming) Reading's work: The mechanisms of online chat as social interaction. In G. Stahl (Ed.), *Studying Virtual Math Teams*. New York, NY: Springer Publishing.
- Zemel, A. & Cakir, M. (Forthcoming) Combining coding and conversation analysis of VMT chats. In G. Stahl (Ed.), *Studying Virtual Math Teams*. New York, NY: Springer Publishing.
- Zemel, A., Koschmann, T., LeBaron, C., Feltovich, P. (2008) "What are We Missing?" Usability's Indexical Ground." *Computer Supported Cooperative Work*. 17:1 (63-85).
- Zemel, A., Xhafa, F., & Cakir, M. (2007). What's in the mix? Combining coding and conversation analysis to investigate chat-based problem-solving. *Learning and Instruction*, 17(4), 405-415.
- Zemel, A., Xhafa, F., Stahl, G. (2005). Analyzing the Organization of Collaborative Math Problem-Solving in Online Chats Using Statistics and Conversation Analysis. *Lecture Notes in Computer Science*, Volume 3706, Pages 271 – 283.

Conference Presentations

- Koschmann, T., Zemel, A. (2009) "Optical Pulsars and Black Arrows: Evidently-Vague Pronoun Reference and the Practical Work of Doing Discovery." *Journal of the Learning Sciences*.
- Epperson, T., & Zemel, A. (2008). Reports, Requests, and Recipient Design: The Management of Patron Queries in Online Reference Chats. *Journal of the American Society for Information Science and Technology*. (<http://www3.interscience.wiley.com/journal/121373487/abstract>)
- Zemel, A., Zhou, N., & Stahl, G. (2009). *Collaboration and Chat: Recipiency in Online Math Problem Solving*. Paper presented at the NCA 95th Annual Convention, Discourses of Stability and Change.
- Zemel, A., Cakir, M. P., Zhou, N., & Stahl, G. (2009). *Learning as a Practical Achievement: An Interactional Perspective*. Paper presented at the Eighth International Conference on Computer Supported Collaborative Learning (CSCL2009: CSCL Practices).
- Zemel, A., Xhafa, F., & Stahl, G. (2005). *Analyzing the organization of collaborative math problem-solving in online chats using statistics and conversation analysis*. Paper presented at the CRIWG International Workshop on Groupware, Racife, Brazil.

Collaborators & Other Affiliations

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