**COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION**

**PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE**

| NSF 09-602 | 10/05/09 |

**FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S)**

DRL - DISCOVERY RESEARCH K-12

**DATE RECEIVED | NUMBER OF COPIES | DIVISION ASSIGNED | FUND CODE | DUNS# (Data Universal Numbering System) | FILE LOCATION**

|  |  |  |  | 002604817 |  |

**EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)**

231352630

**NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE**

Drexel University

**AWARDEE ORGANIZATION CODE (IF KNOWN)**

0032565000

**NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE**

College of Information Science & Technology

**PERFORMING ORGANIZATION CODE (IF KNOWN)**

**IS Awardee Organization (Check All That Apply)**

- SMALL BUSINESS
- FOR-ProFIT ORGANIZATION
- WOMAN-OWNED BUSINESS
- IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

**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 |  |

**CHECK APPROPRIATE BOXES IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW**

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- DISCLOSURE OF LOBBYING ACTIVITIES (GPG I.I.C.1.e)
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- HISTORIC PLACES (GPG II.C.2.j)
- EAGER* (GPG II.D.2)
- RAPID** (GPG II.D.1)
- VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date
- PHS Animal Welfare Assurance Number
- HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number FWA0001852
- Exemption Subsection or IRB App. Date 06/22/09
- INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
- HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

**PI/PD DEPARTMENT**

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TPI 6952834
COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

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NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE | ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Rutgers University Newark | Rutgers University Newark
249 University Avenue | 294 University Avenue
Newark, NJ. 07102 | Newark, NJ. 07102

AWARDEE ORGANIZATION CODE (IF KNOWN) | 0026310000

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE | ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

PERFORMING ORGANIZATION CODE (IF KNOWN)

IS AWARDEE ORGANIZATION (Check All That Apply)

SMALL BUSINESS
MINORITY BUSINESS
FOR-PROFIT ORGANIZATION
WOMAN-OWNED BUSINESS

IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT

REQUESTED AMOUNT | PROPOSED DURATION (1-60 MONTHS) | REQUESTED STARTING DATE | SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$565,158 | 0 months | | |

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

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- RAPID** (GPG II.D.1)
- VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date
PHS Animal Welfare Assurance Number

- HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number
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- INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)

- HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PI CONTENT | PI/PI POSTAL ADDRESS | PI/PI FAX NUMBER | PI/PI NAME | PI/PI POSTAL ADDRESS | PI/PI FAX NUMBER | PI/PI NAME

Department of Urban Education | 110 Warren Street | 973-353-1622 | Arthur B Powell | 973-353-1622 | 973-353-3530 | powellab@andromeda.rutgers.edu

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TPI 6954582
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.
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 5\textsuperscript{th} and 4\textsuperscript{th} Century BC was based on the confluence of labeled geometric diagrams (shared visualizations) and a language of written mathematics (async 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 & Ccking, 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; Mühlporfdt, 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.
- 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.
References Cited


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

<table>
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<th>Institution</th>
<th>Field</th>
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<td>University of Frankfurt</td>
<td>Social Theory</td>
<td></td>
<td>1971-73</td>
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<tr>
<td>Northwestern University</td>
<td>Philosophy</td>
<td></td>
<td>MA 1971</td>
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<td>Northwestern University</td>
<td>Philosophy</td>
<td></td>
<td>PhD 1975</td>
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<tr>
<td>University of Colorado</td>
<td>Computer Science</td>
<td></td>
<td>MS 1990</td>
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<tr>
<td>University of Colorado</td>
<td>Computer Science</td>
<td></td>
<td>PhD 1993</td>
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### Appointments & Professional Experience

<table>
<thead>
<tr>
<th>Year</th>
<th>Position</th>
<th>Institution</th>
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<tbody>
<tr>
<td>2002-present</td>
<td>Associate Professor</td>
<td>College of Information Science &amp; Technology, Drexel University, Philadelphia, PA</td>
</tr>
<tr>
<td>2001-2002</td>
<td>Visiting Research Scientist</td>
<td>BSCW Development Team, CSCW Department, FIT, GMD and Fraunhofer Institutes, Bonn, Germany</td>
</tr>
<tr>
<td>1999-2001</td>
<td>Assistant Research Professor</td>
<td>Department of Computer Science &amp; Institute of Cognitive Science, University of Colorado, Boulder, CO</td>
</tr>
<tr>
<td>1996-1999</td>
<td>Post Doctoral Research Fellow</td>
<td>Center for LifeLong Learning and Design, University of Colorado, Boulder, CO</td>
</tr>
<tr>
<td>1993-1996</td>
<td>Director of Software R&amp;D</td>
<td>Owen Research Inc., Boulder, CO</td>
</tr>
</tbody>
</table>

### Relevant Publications


### Other Publications


Synergistic Activities

- 2003-2009: "IERI: Catalyzing & Nurturing Online Workgroups to Power Virtual Learning Communities." (PI with co-PIs Stephen Weimair and Wesley Shumar) $2,300,000; sponsor: NSF IERI.

- 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).

*Collaborators and Co-Editors:* Clarence (Skip) Ellis, Gerhard Fischer, Raymond Habermann, Walter Kintsch, Thomas Landauer, Curtis LeBaron, Raymond McCall, Jonathan Ostwald, Alexander Repenning, Tamara Sumner (U. Colorado, Boulder); Robert Allen, Annie Fetter, Andrea Forte, Sean Goggins, Mick Khoo, Wesley Shumar, Ian Underwood, Stephen Weimair, Alan Zemel (Drexel U., Philadelphia); Arthur Powell (Rutgers, Newark); Timothy Koschmann (Southern Illinois U., Springfield); Angela Carell, Friedrich Hesse, Thomas Herrmann, Andrea Kienle, Ralf Klammer, Kai-Uwe Loser, Wolfgang Prinz, Markus Rohde, Volker Wulf (Germany); Sten Ludvigsen, Anders Morch, Barbara Wasson (Norway), Kai Hakarrainen (Finland), Cesar Alberto Collazos (Chile); Jan-Willem Strijbos (Netherlands), Chee-Kit Looi (Singapore), Carolyn Rose (CMU), K. Ann Renninger (Swarthmore), Daniel Suthers (Hawaii), Sharon Derry (Wisconsin), Mary Marlino (UCAR).


*Graduate Students, Post-Docs, Visiting Researchers:* Rogerio dePaula, Elizabeth Lenell, Alena Sanusi, David Steinhart (U. Colorado, Boulder); Murat Cakir, Ilene Litz Goldman, Trish Grieb-Neff, Yolanda Jones, Wanda Kunkle. Deb LeBelle, Debra McGrath, Pete Miller, Jimmy Ou, Johann Sarmiento, Ramon Toledo, Jim Waters, Baba Kofi Weusijana, Alan Zemel, Nan Zhou (Drexel U., Philadelphia); Andrea Kienle (U. Dortmund, Germany); Cesar Alberto Collazos (U. Chile, Chile); Jan-Willem Strijbos (Open U., Netherlands); Fatos Xhafa (Open U. Catalonia, Spain); Stefan Trausan-Matu (Politehnica University of Bucharest, Romania); Angela Carell (Bochum U., Germany); Martin Wesner, Martin Mühlpfordt (FhG-IPS, Germany); Elizabeth Charles (Canada), Weiquin Chen (Norway), Juan Dee Wee (Singapore).
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**

<table>
<thead>
<tr>
<th>University</th>
<th>Degree</th>
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<tbody>
<tr>
<td>University of Wisconsin Madison</td>
<td>History BS 1989</td>
</tr>
<tr>
<td>University of Wisconsin Milwaukee</td>
<td>Human Resource Development MS 1990</td>
</tr>
<tr>
<td>University of Minnesota Twin Cities</td>
<td>Software Engineering (Computer Science) MS 2003</td>
</tr>
<tr>
<td>University of Missouri Columbia</td>
<td>Information Science and Learning Technology PhD 2009</td>
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</table>

**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**


**Other Publications**


**Collaborators & Other Affiliations**

*Collaborators and Co-Editors*: Sanda Erdelez (Missouri), James Laffey (Missouri), Chris Amelung (Yale), Ichun Tsai (University of Akron), Gerry Stahl (Drexel), Carolyn Rose (CMU), Matt Schmidt (Missouri).

*Dissertation Advisors*: James Laffey, Sanda Erdelez, Chi-Ren Shyu & Joi Moore (University of Missouri – Columbia).
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

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


### Other Publications


TPI 6952834
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
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)

C. PUBLICATIONS
Related Publications


Other Publications
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.
- 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.


PUBLICATIONS


**SYNERGISTIC ACTIVITIES**


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, *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  
Rennenger, 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

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

Professional Preparation

<table>
<thead>
<tr>
<th>Institution</th>
<th>Field</th>
<th>Years</th>
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<tbody>
<tr>
<td>University of Passau, Germany</td>
<td>Literature</td>
<td>1994-1995</td>
</tr>
<tr>
<td>Western Michigan University</td>
<td>Foreign Language and Literature/ Philosophy</td>
<td>BA 1996</td>
</tr>
<tr>
<td>University of Texas at Austin</td>
<td>Library and Information Science</td>
<td>MLIS 1998</td>
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<tr>
<td>Georgia Institute of Technology</td>
<td>Human-Centered Computing</td>
<td>PhD 2009</td>
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</table>

Appointments & Professional Experience

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

Relevant Publications


Other Publications


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 Ehrdt, Christopher Jordan, Vanessa Larco, Achille Brighton, Kevin Zeigler, Heather Chang (BS Students)
Ian Underwood runs the Ask Dr. Math service for the Math Forum @ Drexel University.

**Professional Preparation**

<table>
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<th>Institution</th>
<th>Degree/Field</th>
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<tr>
<td>Purdue University</td>
<td>Math and Computer Science</td>
<td>BS 1983</td>
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<tr>
<td>Northwestern University</td>
<td>Learning Sciences</td>
<td>MS 1992</td>
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**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 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**

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

Other Publications


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 Rosè, Rohit Kumar (CMU, Pittsburgh), John D. Bransford, Drue Gawel, Susan Mosborg, Nancy Vye (University of Washington, Seattle); Vanessa Sviha (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 teaches, publishes and conducts research in computer-mediated communication (CMC) and computer-supported collaborative learning (CSCL).

**Professional Preparation**

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<tr>
<th>Institution</th>
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<tr>
<td>University of Pennsylvania</td>
<td>Regional Science Economics</td>
<td>BA 1976</td>
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<tr>
<td>University of Pennsylvania</td>
<td>Regional Science</td>
<td>MA 1976</td>
</tr>
<tr>
<td>Temple University</td>
<td>Rhetoric and Communication</td>
<td>PhD 2002</td>
</tr>
<tr>
<td>Southern Illinois University School of Medicine</td>
<td>Medical Education</td>
<td>Postdoc 2002-04</td>
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<tr>
<td>Drexel University</td>
<td>College of Information Science &amp; Technology</td>
<td>Postdoc 2004-06</td>
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**Appointments & Professional Experience**

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<th>Institution</th>
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<tbody>
<tr>
<td>2006-present</td>
<td><strong>Associate Teaching Professor</strong></td>
<td>Department of Culture and Communication, College of Arts and Sciences, Drexel University, Philadelphia, PA</td>
</tr>
<tr>
<td>2004-2006</td>
<td><strong>Research Manager</strong></td>
<td>College of Information Science &amp; Technology, Drexel University, Philadelphia, PA</td>
</tr>
<tr>
<td>2002-2004</td>
<td><strong>Post Doctoral Research Fellow</strong></td>
<td>Department of Medical Education, Southern Illinois University School of Medicine, Springfield, IL</td>
</tr>
<tr>
<td>2000-2002</td>
<td><strong>Instructor</strong></td>
<td>Department of Communication Science, Department of Speech Communication, Temple University, Philadelphia, PA</td>
</tr>
<tr>
<td>2000-2002</td>
<td><strong>Instructor</strong></td>
<td>Department of Communication, Ursinus College, Collegeville, PA</td>
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</tbody>
</table>

**Relevant Publications**


Conference Presentations


Collaborators & Other Affiliations

Collaborators: Chuck Goodwin (UCLA), Curtis LeBaron (Brighan Young University), Wesley Shumar, Gerry Stahl, Stephen Weimar, (Drexel U., Philadelphia); Timothy Koschman (Southern Illinois U.); Anita Pomerantz (SUNY Albany), Garry Dunington (Southern Illinois U.), Murat Cakir, Ramon Toledo, Nan Zhou (Drexel U., Philadelphia); Fatos Xhafa (Open U. Catalonia, Spain); Stefan Trausan-Matu (Politechnica University of Bucharest, Romania); Martin Wesner, Martin Mühlpfordt (FhG-IPSI, Germany); Elizabeth Charles (Canada), Terrence Epperson (The College of New Jersey).

Graduate Students: Murat Cakir, Johann Sarmiento, Ramon Toledo, Nan Zhou, Theodorus Katerinakis (Drexel U., Philadelphia)