

**02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and
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Submit only ONE copy of this form for each PI/PD and co-PI/PD identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. **DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.**

PI/PD Name: Arthur B Powell

Gender: Male Female
Ethnicity: (Choose one response) Hispanic or Latino Not Hispanic or Latino

Race:
(Select one or more)
 American Indian or Alaska Native
 Asian
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White

Disability Status:
(Select one or more)
 Hearing Impairment
 Visual Impairment
 Mobility/Orthopedic Impairment
 Other
 None

Citizenship: (Choose one) U.S. Citizen Permanent Resident Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name):

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project

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Race Definitions:

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Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

Black or African American. A person having origins in any of the black racial groups of Africa.

Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

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PI/PD Name: Gerry Stahl

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Race:
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 American Indian or Alaska Native
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Disability Status:
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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Not Listed

REVIEWERS NOT TO INCLUDE:

Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/If not in response to a program announcement/solicitation enter NSF 08-1		FOR NSF USE ONLY	
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TITLE OF PROPOSED PROJECT Cyber-math: Developing mathematical reasoning through diverse collaborations			
REQUESTED AMOUNT \$ 999,571	PROPOSED DURATION (1-60 MONTHS) 36 months	REQUESTED STARTING DATE 09/01/09	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
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PI/PD FAX NUMBER 973-353-1622			
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CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 08-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

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Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes

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The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

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The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
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This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

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Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

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NAME			
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Cyber-math: Developing mathematical reasoning through diverse collaborations

Project Summary

This *empirical proposal for emerging research in cyberlearning of mathematics* explores how a broad diversity of students can be involved in online collaborations that promote the development of math reasoning. This significantly extends recent NSF-supported research on virtual math teams (at Drexel) and on mathematical reasoning (at Rutgers) by mixing students from diverse backgrounds in collaborative online groups and by supplementing leading-edge networked communication technologies with dynamic math simulations to support mathematical inscriptions, visualizations, abstractions and representations by groups of students.

This research introduces into the design/test/study cycle computer representation and manipulation of mathematical phenomena, supporting conceptualizations in the domains of algebraic sequences, patterns, combinatorics, probability, social choice problems and geometry. It extends innovative methods of evaluating learning by focusing on the *group-level processes* that lead to pattern recognition, logical argumentation, intermediate abstractions and multi-modal representations. It further develops recent theories of computer-supported collaborative learning with detailed empirical descriptions of social practices of small online groups that accomplish cognitive math tasks. In particular, it explores these design, methodology and theory issues within a context of systematic student diversity, both socio-economic and geographic-cultural.

The success of cyberlearning requires the extension of research in a number of directions. This project extends previous NSF-supported research by the PIs to its logical next step: to support online math collaboration in *culturally diverse* small groups. A major challenge in introducing diversity into collaboration is the difficulty of overcoming differences in background knowledge and conceptualizations. The proposed research will explore the use of computer technology to provide relevant online resources and to support conceptualization with *dynamic math objects*, simulations and representations. This will simultaneously extend a proven tool for individual math learning to small-group cyberlearning.

Intellectual Merit

The Cyber-math project extends recent research findings in *technology design, math pedagogy, research methodology, cognitive theory* and *collaboration practice*. Previous investigations at the Math Forum of computer simulations (ESCOT) and of support for virtual math teams (VMT) will be merged—integrating chat, wiki and simulation media for individual, small-group and community knowledge building. Cyber-math presents math worlds for groups of students in formal and informal online settings to explore together, producing multiple representations of fundamental math concepts. The research focuses on group-level cognitive phenomena, departing from the psychological tradition of viewing group events in terms of their effects on individual minds and from the sociological tradition of modeling only non-cognitive group processes. Findings on student reasoning from Rutgers are synthesized with the theory of group cognition under development at Drexel, to elaborate a theoretical understanding of collaborative mathematics grounded in fine-grained interaction analysis.

Broader Impact

The Cyber-math project addresses a major issue for cyberlearning, its applicability across the range of learning contexts and the diversity of learners. It does this by studying a broad diversity of students under similar conditions—coming from school settings, meeting in the Cyber-math environment, discussing core issues in the gateway domains of abstract math reasoning. Rather than observing relatively homogeneous groups, this project forms collaboration groups across SES boundaries from *urban and suburban schools and from the US and abroad*. It explores and helps realize the potential for universal and global cyberlearning of mathematics. It will result in an on-going global service for cyber-math.

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Facilities, Equipment and Other Resources	2	_____
Special Information/Supplementary Documentation	0	_____
Appendix (List below.) (Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)	_____	_____
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Cyber-math: Developing mathematical reasoning through diverse collaborations

Project Description

Proposed Research

Project Overview

Cyber-math is an *empirical* proposal for *emerging research in cyberlearning* in the STEM field of *mathematics*. Specifically, it targets pivotal math learning experiences of algebraic sequences and patterns, combinatorics and probability, geometry and social choice. The project research explores how a broad *diversity of students* can be involved in online collaborations that promote the development of mathematical reasoning. This significantly extends a number of results of recent NSF-supported research. The project has several interrelated goals, research questions and activities in the areas of *technology* design, *mathematics learning* and *pedagogy*, *research methodology*, *cognitive theory*, and *collaboration practice*. The project entails basic research and employs qualitative methods.

Project partners. The Cyber-math Project is necessarily an interdisciplinary collaboration of many partners with complementary contributions to the project. *Arthur B. Powell* and his team at Rutgers University at Newark bring expertise in math education, including research in student math reasoning, in math teacher training and international collaboration. *Gerry Stahl* and his team at Drexel University's information school contribute expertise in computer-supported collaborative learning (CSCL), group cognition and the Virtual Math Teams (VMT) Project. The *Math Forum* is an NSF NSDL-supported digital library of school math resources (over a million web pages, mostly contributed by its user community of three million unique visitors per month) which will host the cyber-math service and which brings a 15-year history of research and service in online math discourse. Researchers and teachers in urban and suburban schools in the US and abroad will prepare and coordinate the participation of diverse students.

Project goals. The concrete project goal is to develop a research-based online math service that could ultimately be maintained by the Math Forum and offered to individuals, groups and schools universally. More generally, the project goal is to conduct the research necessary to guide the design of future cyberlearning services and interventions. This requires an integrated design-based research effort that explores: issues of technology design for the cyber platform, pedagogy design for the math resources offered, methodological considerations of how to analyze what takes place in the service, theoretical concerns about the nature of the phenomena analyzed and questions about the practices involved in the service. A focal research question will be how to support a diversity of backgrounds within the student groups.

Project vision. This project envisions and works toward an online service available to people everywhere, with any background, across learning contexts (formal schooling, informal) and ages (teens, lifelong). It provides valuable experiences that enhance mathematical invention, discovery and comprehension through collaborative discourse. It focuses on fostering math experiences in the “gateway” areas of math that build skills and understanding in abstraction and logical analysis. It takes advantage of the inter-animation of diverse perspectives in collaborative learning by bringing together learners from different cultural, socio-economic and national populations to interact and learn together.

Problem Addressed

The need to improve the level of math knowledge and math self-confidence in America is well documented. Perhaps more important than the ability to perform standard mathematical procedures is the refinement of “deep understanding”—an elusive goal. Recent research in mathematics education suggests that so-called deep understanding consists in the ability to engage in math discourse (Cobb, Yackel, & McClain, 2000; Powell & Maher, 2002; Sfard, 1998, 2000b) and the ability to relate “multiple realizations” of a given math phenomenon (Çakir, 2009; Sfard, 2008; Stahl, 2008a).

The US is concerned about its ratings on math tests compared to other countries and wants to “catch up.” However many of the countries at the top of the rankings—such as Singapore, Finland, China—are not satisfied with proficiency in rote math learning, but are making a commitment to transform their educational systems to promote creativity, collaborative discourse and deep learning.

Being able to understand and discuss mathematical relationships is important not just for working in technical and scientific jobs, but for daily life and the health of a democratic society. Citizens must be able to understand statistics, economic charts, polling results, quantitative evidence, argumentation, and so on to engage knowledgeably in political life.

The introduction of algebra and geometry in late middle school and early high school is a critical period in the development of mathematical reasoning skills—epitomized by the abstraction of algebraic variables and the logical deductions of geometric proofs. Unfortunately, many students fail to make this transition effectively. They do not acquire a deep understanding of what these moves mean, perhaps because they have not really *experienced* the necessary insights. This critical experience is not ensured by rote repetition of problems—but largely consists in engaging in math discourse: collaboratively with others and reflectively with oneself. Without it, a student may be condemned to forever face math as a mystery. On the other hand, having the right kind of experience can lead to a lifelong fascination with math and science (Lockhart, 2008).

There are two main reasons why online services can spark math experiences that traditional math textbooks and classrooms often do not: peer discourse and computational support. With peer discourse, a group of students can explore a math topic from multiple perspectives and make their reasoning explicit to each other. Of course, collaborative work on math could also be done face-to-face in classrooms, but it rarely is; often the time, math resources, selection of group members and space to concentrate together are not available on a regular basis. Computational support of an online service can provide special math simulations that help students to explore math relationships (e.g., Geometer’s Sketchpad, Cabri, math applets), as well as shared, persistent media like whiteboards and browsers. Our research has shown that online collaboration with digital media can be highly effective in fostering insightful math experiences (Stahl, in press).

Previous Work

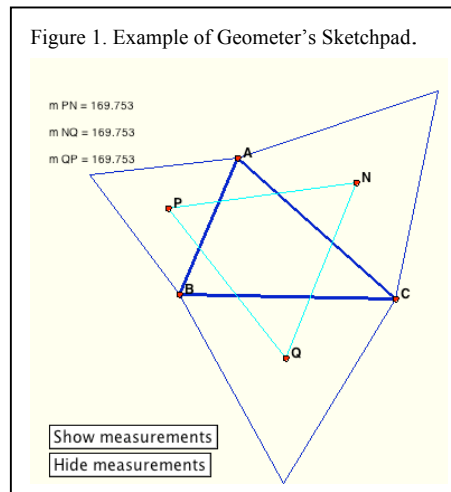
A preliminary illustration of the Cyber-math vision has been prototyped by the Virtual Math Teams (VMT) Project, run by the PIs under previous NSF funding. This project designed, implemented, tested and evaluated—in multiple cycles from 2003 through 2007—an online service at the Math Forum for small groups of students to discuss math. Directed by Stahl and offered through the Math Forum, the service has been used by Powell and associates with schools in New Jersey and Brazil. The VMT Project demonstrated that online group discourse on mathematical topics could result in productive knowledge building by the groups and positive experiences for the participants. Approximately 150 publications (<http://mathforum.org/wiki/VMT?ProjectPapers>) document the effectiveness of various technologies and pedagogies incorporated in the service and analyze data from the online interactions. They report on a methodology of chat interaction analysis tuned to design-based research in this kind of setting, and present findings describing group practices of collaborative math problem solving in the VMT environment. A collection of these papers is forthcoming in a 600-page edited volume (Stahl, in press) covering the technology design, pedagogy of the math topics, analysis methods and group-cognition theory. In particular, Cakir, Zemel & Stahl (submitted) show how student groups enact the digital media affordances to coordinate graphical, narrative and symbolic inscriptions of multiple realizations of math artifacts, while Powell & Lai (in press) analyze the mathematical reasoning of the groups.

Current Challenges

While the VMT Project produced promising progress toward the vision of a cyber-math service, it also revealed challenges that remain. Similarly, recent research into computer-supported collaborative learning (CSCL), the learning sciences, mathematics education and mathematical reasoning has yielded important

insights and new perspectives, but it has raised questions requiring further investigation for application to a cyber-math service.

Previous research demonstrates the need to investigate fundamental issues of diverse learners' cognition and development of mathematical reasoning as they collaborate online to solve challenging, open-ended mathematical problems. To aid learners in constructing problem-solving schemata and in building sets of ever-increasing and layered ideas about particular mathematical concepts, future research should develop strands of structured mathematical tasks that have similar underlying mathematical structures. As students explore each mathematical task and identify, define and resolve problematic situations, we need to acquire insight into how new mathematical ideas emerge from student groups' online mathematical discourse, the facilitation approaches that assist students to maintain their small-group, online interactions and the applicability of these approaches to the use of online collaboration in classroom-based and after-school settings. Moreover, we must also identify the ICT (information and communication technology) resources that students use to communicate mathematically, to represent their mathematical ideas and reasoning, and to present justifications for their solutions.



Research Planned

The proposed Cyber-math Project is designed to meet current challenges through coordinated research into technology design, math pedagogy, research methodology, cognitive theory and collaboration practice.

Technology design. The computer age has transformed the way mathematics is done. Professional mathematicians use computers to simulate phenomena of interest and to compute results that would be impossible to do with paper and pencil. Similarly, computers and handheld digital devices have transformed math education, at least for the luckier students. For instance, simulation software like Geometer's Sketchpad allows an individual student to construct a geometric line drawing involving a triangle and then interact with the placement of the lines, changing the proportion of the triangle sides (see Fig. 1). The software continuously displays the changing values of point coordinates, line segment lengths and triangle areas while changes are made, revealing patterns of change, dependencies and possible constant values. The concrete visual feedback provides a visceral grounding for the students' considerations of relationships and abstract quantities. Hypotheses stated in symbolic terms can be explored using visual reasoning. Such experiences have proven valuable for individual learning.

A current challenge for services like cyber-math is to provide a facility like Geometer's Sketchpad in an online collaborative environment. Such a tool for interactive exploration would have to be designed and programmed to support collaborative usage. This means that any change that one student made would simultaneously appear on the computers of everyone in the online group. There would have to be functions to support coordination of manipulations and to avoid conflicts. Above all, there would have to be means for communicating about what someone wanted to try out as well as about observations that others made. As was seen in the VMT Project (Stahl, 2006e), support for deictic referencing with a pointing tool would be helpful. To support persistence and reflection on trajectories of group inquiry, a history function would also be valuable, as would a way to save and annotate snapshots. This could all be accomplished through integration with chat, whiteboard, graphical referencing and wiki components similar to those in the VMT environment (Stahl, 2008b).

A related challenge for cyber-math technology is to incorporate computer simulations of mathematical phenomena. For instance, it is possible to develop simulations of probability problems, where students can select parameters of the problem, defining a start state, and then allow the simulation to run, using

random events and displaying end states. Such simulations allow students to observe and explore carefully crafted representations of mathematical phenomena. Previous research at the Math Forum as part of the ESCOT Project investigated the design, development and use of such simulations by individual students. Like the geometry simulation previously discussed, incorporation of computer simulation applets for algebraic sequences and patterns, combinatorics and probability, and social choice problems would need to be specially developed for integration into the larger collaboration environment.

Math pedagogy. Several major pedagogical challenges face the development of a cyber-math service:

- How to design math resources, educational interventions and software support for online teams that consist of students with diverse mathematical, socio-economic and geographical-cultural backgrounds.
- How to develop curricular units in the areas of algebraic sequences and patterns, combinatorics and probability, social choice, and geometry that will provide challenging problems for online teams of students to explore and discuss productively.
- How to integrate computational simulations and interactive geometric representations into the curricular units.
- How to scaffold the curricular units with background knowledge, resources, feedback, and so forth to promote common ground and to encourage mathematical insights.

The project will use a design-based approach to developing and evaluating curricular units. The problems within each unit will be designed and the evaluation based on how students engage with them. We intend to design online curricular units that elicit and support students' mathematical reasoning and their building of convincing arguments.

Research methodology. In order to understand what takes place in cyber-math environments, it is important to be able to recreate in detail the experience that was shared by the student team. In the VMT Project, a Replayer tool was used for conducting fine-grained chat interaction analysis at the group unit of analysis. This will have to be extended to capture activities in the simulations and geometric representations. We will use the Replayer and chat logs to analyze how student groups with diverse member backgrounds and with dynamic math visualizations engage in math problem solving and in math discourse.

Cognitive theory. In the VMT Project, descriptions of group-cognitive accomplishments could be made without knowledge of the characteristics of the individual participants. In extending the theory of group cognition in online math collaboration to explicitly consider diverse groups of students, knowledge of student backgrounds may become relevant. At least statistical information on different populations of students involved in the proposed project will have to be taken into account. Groups will be formed to provide collaborative-problem-solving data on small groups with systematic mixes of backgrounds.

Collaboration practice. This project will develop an online math service enhanced with computer simulations of mathematical phenomena and focus on the use of the online service to engage a diverse student population, from urban and suburban communities, here and abroad, collaborating synchronously and asynchronously to solve open-ended but well-designed mathematics tasks that are cognitively demanding (American Educational Research Association, 2006) and that promote the construction of mathematical reasoning and problem-solving schema (Powell et al., in press). The challenging math tasks will invite students to negotiate interpretations, analyses and other aspects of their work, coalescing toward a solution. The strands of mathematical tasks will be structured to promote the construction of problem-solving schemata and have similar underlying mathematical structures so that student groups can build sets of ever-increasing and layered ideas about particular mathematical concepts. These are important and significant foci of our proposed research.

Participants. An important feature of the research is the composition of the collaborative, small-group teams. Students will work in teams of four, first within a school site and later where half of their colleagues are physically located at a remote school site. They will collaborate online and have available

a variety of online tools to search for information, represent their ideas and present their reasoning. To communicate and collaborate, participating students in our study will use a significantly extended version of the multi-modal, online tool used in the VMT project, which will provide automated data collection.

Research team. The composition of our research team is also significant. The team is multi-disciplinary. Besides the senior researchers, it will include graduate and undergraduate students as well as high school mathematics teachers. This research will occur in both regular mathematics classes and in after-school, informal learning environments. At each school, one or two mathematics teachers will work as co-investigators. They will participate in planning, implementing and debriefing the research sessions. In the debriefing sessions, among other issues, the research team will reflect on the use of Cyber-math technology for collaborative mathematics problem solving, evaluate the use of the software and the strands of mathematics problems in both in-class and after-school settings, and assess the developing pedagogy of online intervention, and how the project can be integrated further into the formal setting of high schools. With these considerations, the teacher partners will be integral to the research.

Research Questions

- *Technology research question:* In what ways can the Cyber-math software platform be designed to support graphical, narrative and symbolic inscriptions and simulations during synchronous and asynchronous interaction of small groups of geographically separated and culturally diverse students engaged in mathematical discourse?
- *Learning and pedagogy research question:* How can mathematical topics be presented, scaffolded, scripted and moderated to support group reasoning about core understandings—from multiple perspectives and representations—of fundamental relationships in algebraic sequences and patterns, combinatorics and probability, social choice and geometry?
- *Methodology research question:* How can adequate data be generated and analyzed in order to analyze and describe how student groups achieve cognitive accomplishments related to the mathematics they are discussing?
- *Theory research question:* What is the nature of cognition at the level of the small groups such that accomplishments at this level interact productively with the individual cognition of engaged students?
- *Practice research questions:* How is the interaction of online small groups of math students different when the groups are diverse in terms of their socio-economic backgrounds, their geographic-cultural characteristics and their perceived or actual math competence? How do students from diverse backgrounds (geographic and socio-economic) collaborate online to solve challenging mathematics problems? What mathematical reasoning emerges from small-group collaboration?

Significance of Research

This project will have five significant outcomes: (1) It will enhance the VMT online math environment with computer simulations of mathematical phenomena and other features to support diverse groups of math students. (2) The project will design curricular modules in algebra, combinatorics, probability, social choice and geometry for use in the online collaborative math service. (3) Through this study, we will further evolve methods to evaluate the development of mathematical reasoning by diverse student groups through online collaboration. (4) We will develop a model of how students of different SES and geographical locations work in online collaborative teams to solve cognitively demanding strands of mathematical tasks. (5) The project will accumulate experience in how to introduce into formal schooling collaborative, online mathematical problem solving among diverse students in distant locations.

The proposed research has three significant, beneficial features for participants: (a) The first concerns the development of students' mathematical abilities. Through working on multiple strands of mathematical tasks, participants will build their mathematical ideas related to math concepts and further develop their ability to reason mathematically. Specifically, the tasks will engage participants in important cognitive and discursive aspects of mathematical problem solving such as employing heuristics, making

connections, specializing, generalizing, explaining, reflecting, conjecturing, justifying and posing problems. Furthermore, participants will construct problem-solving schemata or shared practices.

(b) The second relates to creating social, intellectual networks among students in urban and suburban communities, here and abroad. Participants in the study will engage in intercultural and international mathematical exchanges to develop their reasoning in mathematics. Through these collaborative encounters, urban and suburban participants, here and abroad, will construct social, intellectual networks. As we observed in our pilot studies, participants will particularly enjoy the social interaction of working together on interesting, challenging mathematics problems with members of other teams.

(c) Our third beneficial feature refers to our pedagogical goal to construct a model for learning pathways using ICT to involve low-SES students, who typically do not have opportunities to engage these technologies to develop their mathematical reasoning skills and to advance their ability to communicate mathematically. To this end, the study engages urban students with a state-of-the-art ICT tool to develop an inter-city as well as international community of mathematics learners, uniquely providing access to learning tools and environments of advantaged students. Furthering this goal, the model will demonstrate how urban students develop intellectual and social relations with students from different domestic and national communities, and how this contact serves to broaden their perspective on themselves as members of a global community of (mathematics) learners.

Together, these project benefits demonstrate the potential of cyberlearning and explore the practicalities of implementing cyberlearning within the critical domain of mathematical reasoning.

Results from Previous NSF Research

Rutgers University

The proposed Cyber-math Project builds upon and extends three previous NSF awards to the research team at Rutgers University. In two grants to Rutgers (MDR-9053597 and REC-9814846), we traced the development of mathematical ideas in children from first grade through secondary, college, and beyond. Our current NSF-supported investigation (REC-0309062) examines the mathematics learning of urban, low-SES, middle-school students in the informal environment of an after-school enrichment program in Plainfield, New Jersey. Our earlier longitudinal and cross-sectional studies involved students from three New Jersey districts: (a) Kenilworth, a diverse working-class, immigrant community (19 years); (b) New Brunswick, an urban, low-SES district (4-6 years); and (c) the suburban district of Colts Neck (6 years). Extensive videotaping in classrooms and clinical settings of students working in small groups throughout our projects has made it possible to study group and individual students' cognitive growth within a variety of contexts and to pursue the subtleties of group interaction and student thinking. We have traced the continued building of ideas, anchored in connected, long-term content explorations in several domains: (a) counting and combinatorics and probability, (b) algebra, (c) probability, (d) pre-calculus and (e) calculus. We have accumulated a rich collection of open-ended tasks that elicited from students a variety of forms of reasoning. Others have replicated some of these tasks in forty-four states and the District of Columbia. Moreover, 20 dissertations and over 60 publications have resulted from this work.

Drexel University

At present, our Drexel research team is in the midst of two NSF-supported investigations (IERI 0325447 and SBE-0518477). The first project has completed several iterations of design, development, testing and analysis of the Virtual Math Teams (VMT) service at the Math Forum. Over 1,000 student-sessions have taken place, averaging an hour each. Six doctoral students are working on dissertations based on data from this project. Over 80 publications associated with this project have appeared already. Software for the VMT environment is being released as Open Source and is being used by other researchers in collaboration with this project. A methodology for the analysis of online collaborative learning has been developed, called "chat interaction analysis." A re-player tool has been developed to provide adequate access by researchers to the sequentially unfolding interactions in the VMT environment's chat and

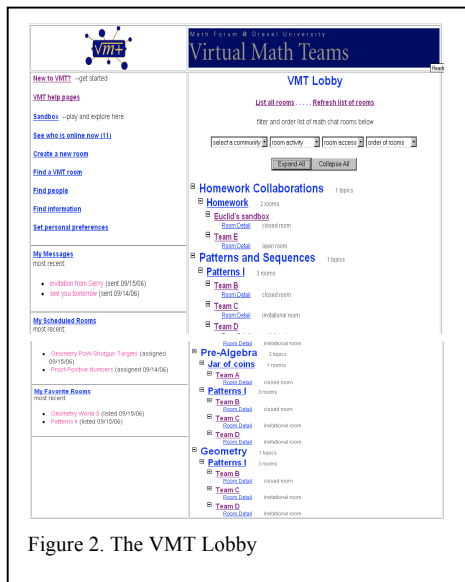


Figure 2. The VMT Lobby

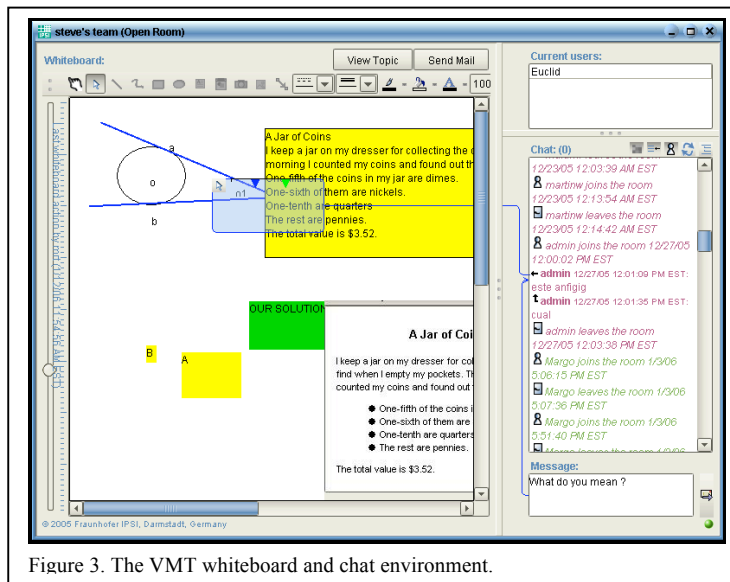


Figure 3. The VMT whiteboard and chat environment.

whiteboard spaces. Several key features of online collaborative learning have been analyzed. Analysis of the interactions included use of a graphical representation of interaction threading. Figures 2, 3 and 4 show the VMT Lobby, Chat/Whiteboard environment and Wiki.

The second project brings together interdisciplinary researchers interested in how to promote online communities for collaborative cyberlearning. The original intention was to build the foundation for an NSF Sciences of Learning Center focused on Engaged Learning in Online Communities (ELOC). The project has held several workshops and generated smaller scale collaborations among research labs, both nationally and internationally, several using the VMT software.

Math Forum

The Math Forum at Drexel is an online digital library for K-12 mathematics, hosting a number of services for teachers and students. It has received NSF support for a variety of research projects during its successful 15 year existence. Perhaps most relevant is its involvement in a project from 1998-2001: Educational Software Components of Tomorrow (ESCOT) (REC-9804930). This investigated how software innovations can accumulate, integrate, and scale up to meet the needs of systemic reform of K-12 mathematics and science education. Its goal was to develop an understanding of how to compose lessons by combining graphs, tables, simulations, algebra systems, notebooks, and other tools available from a shared library of reusable components. Applets developed in this project were integrated with curriculum in the Math Forum Problem-of-the-Week, a predecessor of VMT.

Lessons Learned

These projects has been concerned with understanding engaged learning in the domain of mathematics. In particular, our work in the ELOC project's PI meetings and public workshops, identified the following signature challenges to cyberlearning:

- How to deepen the learning that takes place, given that most current examples of successful engaged learning in online communities remains shallow.
- How to integrate pedagogical scaffolding, technological affordances, and motivational sociability.

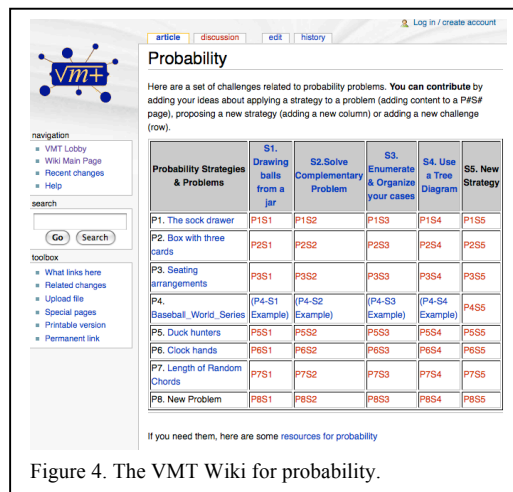


Figure 4. The VMT Wiki for probability.

- How to introduce inquiry learning in student-centered informal online communities into social contexts dominated by formal schooling.

Our proposed project is deeply informed by these results. The first and second items are explicit features of our study. To address the need to deepen the online learning, a significant element of our design of tasks is what we call “strands of mathematical problems,” a sequence of mathematically connected tasks that enable student groups to develop schemata of mathematical concepts and problem-solving strategies. From the question of how to integrate pedagogical scaffolding, technological affordances and motivational sociability emerged our third guiding research question concerning issues of facilitation. An explicit product of this study is to grapple with how to integrate into formal school settings variants of the environment we create in an informal, after-school atmosphere. The teachers from our partner schools will assist us in this endeavor and during the research period will implement our project in regular math courses.

From our previous research on the development of mathematical thinking, we have gained a detailed understanding of how learners work with data; of how reasoning and thinking function in communities of learners; and of how the building of fundamental mathematical ideas over time plays an important role in the development of mathematical understanding. From results of interviews (see Maher, 2005), students emphasize the importance of having been able to build mathematically rich ideas from limited information, developing original mathematical techniques rather than being given procedures to master, and explaining their ideas to each other, and understanding others’ mathematical reasoning and justification. They report that the process enabled them to build confidence, to take risks in new situations, and to work through difficulties that arose, and in so doing to deepen their understanding of the involved mathematics while constructing mathematical arguments to explain their ideas. Moreover, students value having had flexible and extended time to work on and think deeply about a problem, even if it means leaving the problem alone for a while and doing something else. What has been underscored for us is the importance of minimizing facilitator interventions and maximizing student discourse (Francisco, 2005). All these conditions—tasks, tools, time, and limited intervention—contribute to the generation of a community of learners willing and open to exchanging ideas. In the proposed study, these conditions are expressly incorporated in our research design. As the objective of our research design indicates, we intend to examine how to express these conditions in our online environment to create online environments that elicit and support mathematical reasoning and the building of convincing arguments.

Findings from our recent study of mathematical thinking—Informal Mathematics Learning Project (Maher, Powell, Weber, & Lee, 2006; Powell, Maher, & Alston, 2004; Weber, Maher, Powell, & Stohl Lee, 2008; Weber et al., in press)—are also instructive for our proposed study. We discovered that we could establish many of the conditions from the previous longitudinal study with a new group of students in a relatively short period. As a result, sharing and evaluating mathematical ideas and justifications have become part of the socio-mathematical norms of this environment. In posing modifications and extensions of given tasks, students displayed evidence of mathematical understanding and awareness of generalizations of mathematical ideas. Students invented or adopted colloquial terms to express their thinking about mathematical objects, ideas and events. Students also reasoned from evidence, and used symbolic and graphical representations of mathematical ideas and relationships to settle disagreements. Informed by these findings, we will examine how these findings derived from face-to-face problem solving are expressed in online collaboration.

Research Design

Theoretical Framework

Central to our understanding of doing and communicating mathematics is the construction of representations. These include graphs, diagrams, written symbols, gestures, or specific language use produced for personal or public consumption to develop, investigate, and convey ideas, results, and lines

of reasoning. Building and discussing inscriptions (written representations) are essential to building and communicating mathematical and scientific concepts (Dörfler, 2000; Lesh & Lehrer, 2000; Powell & Bairral, 2006; Speiser, Walter, & Maher, 2003; Speiser, Walter, & Shull, 2002). As learners invent or appropriate inscriptions—or, more generally, representations—they change their relationship to what the representation signifies and, as such, turn abstract ideas into concrete, personal ones. Over time, their representations are carried forth, revisited, used, modified, and extended. As learners engage in mathematical investigations, they frequently retrieve and critically re-examine their earlier ideas for particular features as they build new knowledge (Davis, 1984; Davis & Maher, 1990; Maher, 2005). They monitor earlier ideas in the process of attempting to make sense of new experiences. As they explain, justify, and convince others of their ideas, a re-examination of the relationships between representations is often triggered (Maher & Speiser, 1997). In this way, learners recognize certain features of their representations. When they receive challenges from peers or a facilitator to explain their ideas, learners frequently modify, reject or extend their original knowledge representation and fashion arguments to support their ideas and generalizations. As learners cycle among representations and justifications, they construct new knowledge. The theories they pose are subsequently modified and refined in contexts that encourage both personal exploration and social interaction. Moreover, mathematical communication supports the construction of representations (Powell, 2003) and can constitute a heuristic in mathematical problem solving (Mason, Burton, & Stacey, 1985; Powell & Maher, 2003).

Our theoretical framework is also informed by work on the interaction between the inscriptions and discourse of learners as windows into learners' development of mathematical ideas, heuristics, and reasoning (Larson, 1995; Powell, 2003; Powell & Maher, 2002; Speiser et al., 2002; Walter & Maher, 2002). Discourse here refers to language (natural or symbolic, oral or gestic) used to carry out tasks—for example, social or intellectual—within a community. In agreement with Pirie and Schwarzenberger (1988), student-to-student or peer conversations are mathematical discussions when they possess the following four features: are purposeful, focus on a mathematical topic, involve genuine student contributions, and are interactive. A tenet of our theoretical perspective, like other sociocultural perspectives (e.g., Cole, 1996; Schleppegrell & Colombi, 2002), is that to do mathematics students must be able to talk or otherwise communicate mathematically, not just be able to solve routine mathematics problems. As Sfard (2001) proposes, “communication should be viewed not as a mere aid to thinking, but as almost tantamount to the thinking itself” (p. 13). We believe that mathematical language and mathematical thinking develop simultaneously in social interaction. As with other scientific languages, the pathway into using academic language in mathematics is through social experience (Palincsar, 1998; Vygotsky, 1978). Because meanings are construed through language, the language that construes particular social meanings comprises the register of that social context (Schleppegrell, 2004, pp. 45-46).

Discourse and representations are means for engaging mathematical ideas and for displaying mathematical reasoning and typically occur through face-to-face or textual means. Computer communication technologies are also vehicles for learners to communicate representations and discuss mathematical ideas (Kramarski, 2002; Mishra & Koehler, 2006). From the perspective of computer-supported collaborative learning (CSCL), Stahl (2005) presents a theory of group cognition as knowledge building at the level of small groups of students functioning within a computer environment. He calls for further empirical research “to clarify the nature of shared knowledge and group cognition” (p. 87). From earlier studies, we have found that given particular pedagogical conditions and student development of socio-mathematical norms that socially emergent cognition can indeed be the byproduct of collaborative problem solving (Powell, 2006).

Sfard (2000a) theorizes signs are constitutive rather than strictly representational since meanings are not only presented in signs but also come into existence through them. The mutually constitutive nature of meanings and signs supports analysis of the discursive emergence of mathematical ideas, reasoning and heuristics. On the one hand, signs can represent encoded meanings that—based on previous discursive interactions—interlocutors can grasp as they decode the signs. On the other hand, through moment-to-moment discursive interactions, interlocutors can create signs and, during communicative actions, achieve

shared meanings of the signs. The sameness of meaning for interlocutors that allows for success of their communication is not something pre-existing but rather an achievement of the communicative act. This accomplishment may compel interlocutors to bring into existence signs to further their discourse. As artifacts with shared meanings, signs emerge in group collaboration.

Research using the VMT environment has identified typical social practices or interactional methods that students use when engaging in online collaborative discourse (Stahl, 2007b). For instance, they may exchange greetings, explore the software interface, orient to the given problem, negotiate about distribution of skills or roles, constitute the problem and an approach to the problem, make proposals on solving the problem, or engage in uptake of proposals by the group, clarify, work on solutions (constructing math objects, drawing, labeling, bringing in information, bridging to past discussions, etc.), check tentative solutions, wrap up and close discussion.

Stahl (2007a) suggests that the meaning-making process that students engage in to propose, share, understand and make use of mathematical objects, (drawings, special terminology, representations) can be conceived as consisting of layered networks of references and relationships within the discourse. There is a *threading* of the conversational flow, with a particular posting following up on a preceding one (that may not be immediately adjacent in the chat log) and opening the possibility of certain kinds of postings to follow. There is *up-take* of one phrase or action by another, carrying the work of the group ahead. There are often important *continuities* from one posting of a particular individual to the same person's subsequent postings. Various sorts of communication problems can arise—from typos to confusion—and *repairs* can be initiated to overcome the problems. Lines of chat can *reference* items outside the chat, such as whiteboard drawings, formulae learned in the past, or notions raised earlier. Terms and phrases in a posting can serve as *citations* of previous statements, making the former meanings once more present and relevant. This structure of intersubjective meaning making is constitutive of the collaborative knowledge building that takes place in settings like the VMT environment (Stahl, 2006c).

Based on this theoretical framework, we will focus our investigation of mathematical reasoning in diverse collaborations at the group unit of analysis, where meaningful signs and mathematical practices emerge. Of course, learning takes place at both individual and community units of analysis as well, and they are all intimately intertwined. However, we believe that the group knowledge-building processes have not been adequately researched and that they are particularly central for collaborative cyberlearning. Unable to investigate all aspects at once, we focus our research questions, methodology and plan on small-group processes.

Research Setting

The Cyber-math sessions will occur both during regular class periods and in after-school settings in eight secondary schools in four different countries (Brazil, Singapore, South Africa, and USA). The countries are ones in which the PIs have longstanding collaborators and where the necessary infrastructural resources exist. From the United States and Brazil, six different secondary schools will participate, three in each of two countries. In the United States, the three high schools are located in different locales in New Jersey: Newark, Long Branch, and Somerset. In Brazil, three secondary schools are from each of two different cities—Vitória (in Espírito Santo) and Seropédica (in Rio de Janeiro). In each country, two schools are from urban areas and one is from a suburban district. Letters of intent to participate from all schools are included in the supporting documentation. In the final project year, the project will involve a school in each of Singapore and South Africa.

In Seropédica the schools are public and have students between the ages of 12 to 15. The Federal Rural University of Rio de Janeiro is engaged with a teacher professional development project to improve the teaching of mathematics and the use of technology in the mathematics in the two schools. In Vitória, the school is a federal high school whose purpose is to involve students in learning school subjects with technology. Students from these school will be involved in the Cyber-Math Project throughout its three years.

Both the urban-suburban and the US-Brazil mix are purposeful features of our research design. The use of ICT in urban high schools for mathematics instruction tends to be for drill in facts and procedures rather than for interpretation and analysis (Ainley, Banks, & Fleming, 2002; Warschauer, Knobel, & Stone, 2004). The argument offered for this practice is that urban students desperately need to increase their mathematical performance on standardized tests and that without proficiency in facts and procedures they cannot participate in higher-level, cognitively demanding mathematical problems. We believe that—under proper conditions—urban students can participate in high-order, cognitively demanding mathematical tasks and can do so using ICT tools. Moreover, from both social and mathematical perspectives, we believe that urban students can collaborate effectively and productively among themselves and with suburban students here and in another country. This project will evaluate these claims and explore the necessary conditions.

The multi-country feature is another intentional aspect of our research design. Inviting American high school students to engage in mathematical problem solving and to collaborate with teenage counterparts in another country will provide them with important cultural and intellectual experiences. In previous studies, we observed that American high school students are indeed interested and motivated to know teens in other cultures and—given challenging, open-ended problems to discuss—enjoy online intellectual exchanges about mathematical ideas. The time zones of the American and Brazilian schools are similar. From a curricular perspective, Brazilian mathematics instruction is closely aligned with American standards advocated by reformers (National Council of Teachers of Mathematics, 2000; Secretaria de Educação Básica, 2006). Furthermore, in both countries by age 15, the mathematical content that students have studied is roughly equivalent and contains little, if any, work in combinatorics or experience with geometry in a dynamic environment provided by software applications with the functionality of The Geometer's Sketchpad and Cabri. Geometry, combinatorics and probability, and social choice are three of the four mathematical strands of our project and students will use technology with geometric simulation software to explore geometric properties such as those of the bisectors, medians and altitudes of triangles.

In all, from the six different American and Brazilian high schools, 144 students will participate in Cyber-math. In our research design, we refer to a pair of school sites as a *school dyad*. Of the 15 possible school pairings, our study will involve six school dyads, each distinguished by a letter, A to F. We will gather data from each dyad during one and a half years, either during an academic years (AY) or calendar years (CY). School Dyads A, B, and C will participate in Cyber-Math during the academic years of 2009 to 2011, while School Dyads D, E, and F will function during the calendar years of 2010 to 2012. We have composed the school dyads so that we can meet the objectives of our research design and to facilitate investigation of our guiding research questions. Moreover, we will use the design/test/study cycle to adjust the problems and how we facilitate research sessions. We will analyze our data from the perspectives of both within and between school dyads.

Participants

In the first two years of the project, student participants will come from among six schools in the United States and Brazil. In the third year, participating students will be drawn from these schools as well as a school in Singapore and one in South Africa. From each of the six participating American and Brazilian schools, we will recruit 12 students in the tenth grade, each approximately 15- to 16-years old, to be involved in our study. They will use the online environment to create a virtual community of mathematics discourse among local and distant partners. Each of the three Brazilian secondary schools with which we are partnering has students who are learning English as a foreign language and has an interest in improving their oral and written facility in the language. The participants will be recruited from among these students. In school dyad E, the participants will be from two different Brazilian schools and will communicate in Portuguese. We will contrast the mathematical communication in this school dyad with the other dyads. In all school dyads, participants will work in small-group teams each consisting of four students, randomly assigned.

In the first phase of the project, participants in a given team will all come from the same school. They will use the online environment to work together in a culturally homogeneous setting on a series of problems in our algebra strand, allowing them to become familiar with the online system and to build collaboration skills. In the second phase of the project, each team will consist of two participants from one school and two participants from another school. These teams will explore other open-ended mathematical situations in our combinatorics and probability, geometry, and social choice strands. In both phases, teams will function in their own chat room.

In addition to the current functionality of the VMT environment, as digital simulation media (graphing and dynamic geometry applications and applets) are added, participants will have access to these applications as well as general Internet resources. Participants may also paste text and screenshots from other applications such as applets and spreadsheets onto the VMT whiteboard. From the online environment, teams will have a link to an electronic discussion board or wiki where they may publish their solutions and justifications. Teams will be invited to comment on the other teams' solutions and justifications and, in response, to reconsider and possibly revise their posted solutions and justifications.

Task Design

To address our guiding research questions, specific tasks will be used to engage learners in building mathematical ideas and developing their powers of reasoning. We will draw from an extensive body of experience and tasks derived from the longitudinal and cross-sectional research of the Robert B. Davis Institute for Learning at Rutgers on how mathematical meaning and reasoning are built by learners, as well as from the corpus of problems that the Math Forum has developed. Informed by our ongoing formative evaluation during each phase of our study, we will modify tasks and design new ones in response to participants' work.

The mathematical tasks will come from key areas of mathematics: algebra, especially sequences and patterns; combinatorics and probability; geometry; social choice. The tasks will be challenging; participants will not be aware of routine procedures to solve the problems, but will have to collaborate with their teammates to explore solution paths. The tasks will be amenable to a mix of representational systems and will engage participants in employing heuristics, making connections, specializing, generalizing, explaining, reflecting, conjecturing, justifying and posing new problems. We will develop interactive applets to support exploration of some of these (see Figures 5, 6 and 7).

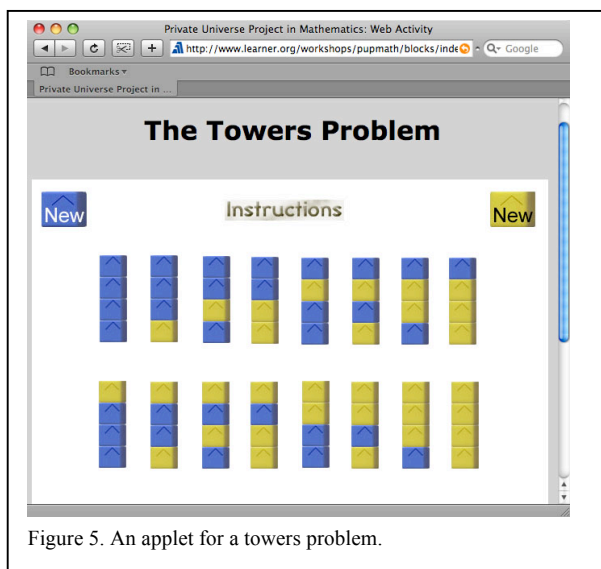


Figure 5. An applet for a towers problem.

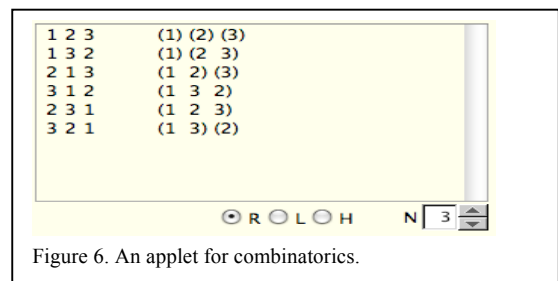


Figure 6. An applet for combinatorics.

Students will work on *strands* of challenging tasks that pertain to the same mathematical ideas (Powell et al., in press). Here we present examples of problems from strands of tasks that involve concepts central to combinatorics, probability and social choice problems. In the following, learners have

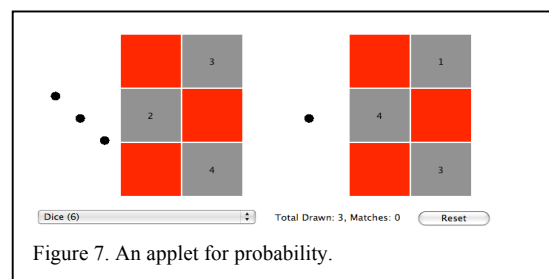


Figure 7. An applet for probability.

opportunities to build robust mathematical schemata related to binomial coefficients and to develop forms of justification such as combinatorial reasoning and ways to articulate an isomorphism between the underlying mathematical structure of seemingly unrelated problems (Francisco & Maher, 2005; Powell, 2003, 2006; Powell et al., in press):

- Towers n -Tall. Your group has two colors of Unifix Cubes. Work together and make as many different towers four cubes tall as is possible when selecting from two colors. See whether your team can plan a good way to find all the towers three, four, five and n cubes tall.
- The n -Topping Pizza Problem. A local pizza shop has asked us to help design a form to keep track of certain pizza choices. A customer can then select from four toppings. List all the possible choices and convince each other that you have accounted for all possible choices.
- The Four-Topping Pizza with Halves. The pizza shop offers four different choices for each half of a pizza. There is also a choice of thick and thin crusts. List all the possible choices.
- The World Series Problem. In a World Series, the first team to win 4 of 7 games is the winner. Assuming both teams are equally matched, what is the probability that a World Series will be won: (a) In four games? (b) In five games? (c) In six games? (d) In seven games? Justify your answers.
- The Taxicab Problem. A taxi driver is dispatched three times in a city with a grid of streets. What is the shortest route from the taxi stand to each point shown on the map? Is there more than one shortest route to each point?
- Social choice. A class of twelve students is given three choices for their final party: cake, pizza or ice cream. The class can only have one of the three treats for their party. Each student is asked to put the three possibilities in order by preference with their favorite first. Given a chart of the votes what type of party would be best for the class.

Data Collection and Analysis

Our unit of analysis is the small-group teams. Consequently, our data will come mainly from logs of the work of the teams. Additionally, we will gather researchers' observations. The sources of small-group teams' work includes the transcripts from the interaction of team members in the online environment and wiki postings, as well as from videotaped pre-session focus group interviews and follow-up focused interviews with student teams. Data from researchers' observations include planning session scripts; session notes, and reflective journals; planning and debriefing meetings; and written observations of the pedagogical activity of the research team as members interact with small-group teams.

Similar to design experiment or design-based research (Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Confrey & Lachance, 2000), our analytic process involves spiraling stages of development in which reflections of ongoing classroom-based research are used to inform subsequent research tasks and other instructional design decisions. We will examine the data from the persistent logs of the online interactions of the teams within a school to monitor what is being captured and will modify data collection techniques as needed. This process will also include a formative evaluation of the social and collaborative functioning of the teams and the progress that they make toward solving the mathematical tasks and presenting their solutions as well as commenting on and critiquing the solutions of other teams.

Our analytic interest focuses on group cognition (Powell, 2006; Stahl, 2005, 2006a, 2006c, 2006d). As such, we will analyze our data with the analytic unit being the small-group team. Informed by the mathematical tasks, analyses of the logs of inscriptions and chat data will allow us to address our research questions. For inquiring into the asynchronous data, our methodology will be based on the work of Bairral (2003, 2004). In addition, we will conduct descriptive micro-analysis using methods of "chat interaction analysis" developed in the VMT project (Stahl, 2007b). This approach adapts the rigorous methods of Conversation Analysis (Sacks, Schegloff, & Jefferson, 1974; ten Have, 1999) to the unique forms of interaction that take place in environments like VMT. It looks at how participants construct shared meaning. It identifies the social practices that small online groups of students create in order to do

mathematics together, such as joint deictic referencing (Stahl, 2006d), synergistic problem solving (Stahl, 2006b) or negotiating math proposals (Stahl, 2006f).

For investigating the development of mathematical ideas and reasoning, we will code for instances in the data of participants' online communications of their discursive attention to any of four markers of mathematical elements—objects, relations among objects, dynamics linking different relations, and heuristics (Gattegno, 1988; Powell, 2003). In their text and whiteboard inscriptions, participants either communicate affirmations or interrogatives about these mathematical elements, and as such, we will code for eight different types of critical events that provide insight into the mathematical ideas of small-group teams. It is possible that an interaction will receive multiple codes. The research team will analyze the mathematical ideas and forms of reasoning that small-group teams produce, tracing the development of their ideas and reasoning patterns over time.

We will also analyze researchers' planning and observation notes, the mathematical tasks, and videotapes of the debriefing sessions and focus group interviews. To analyze our video recordings, we will apply methods for studying videodata developed by Powell, Francisco, and Maher (2003). Using the persistent whiteboard and chat logs to inquire into facilitation approaches that encourage students to coalesce into effective teams, we will develop emergent themes as well as apply *a priori* codes. The codes developed will pertain to categories of facilitator intervention. For instance, a critical event may be defined as a facilitator-team interaction that occasions evidence of a team's mathematical thinking.

Research Schedule

Before the start of the school dyads, we will recruit teachers from all participating schools. From our pilot studies, we already have a working relationship with teachers at four of our six schools. We will also engage teachers in professional development activities relevant to the Cyber-math project, including learning about the VMT environment by collaborating in teams to resolve strands of mathematical tasks. During the three years of our study, each school dyad will function during three time periods. These periods will run September-November and March-May. In the intervening times, we will analyze the collected data.

The three project years will be divided into three overlapping research periods, each lasting one and a half years. The first research period corresponds to Phase I and involves Dyads A, B, C. Phase II consists of the second period with Dyads D and E and the third period with Dyad F. Each period will consist of (1) a first cycle of research sessions, (2) a formative evaluation and preliminary data analysis, (3) a second cycle of research sessions, (4) a second formative evaluation and data analysis, and (5) a third cycle of research sessions.

At the respective schools of Dyads A, C, and F, the research sessions will occur during regular class time in the context of a mathematics course. At each school in the other Dyads, one month before each initial cycle of research sessions, the research team will recruit students by posting and sending home flyers and holding an informational meeting with potential student participants. We will attempt to recruit an equal number of female and male students. During each initial cycle of research sessions, we will engage participants in intra-school, online mathematics problem solving. Informed by our first and second formative evaluations and data analyses, we will engage participants in inter-school online problem solving during the second and third cycle of research sessions. Finally, from November 2011 to June 2012 we will have a summative evaluation, final data analysis sessions, and write research reports.

Research Evaluation

The Cyber-math project is driven by continuous trial, analysis and evaluation due to its design-based approach. Each aspect of the research will be tested in actual usage by student teams. The usage will be analyzed through multi-disciplinary methods. The success of the design will be evaluated based on the analysis of the usage and will result in re-design, to be tested in the next iteration of the project trials.

The success of the project will be judged relative to the five Research Questions listed at the beginning of this Project Description, involving Technology, Pedagogy, Methodology, Theory and Practice:

- *Cyberlearning technology evaluation*: Has the Cyber-math software platform been successfully extended to include math simulations and dynamic math objects? Are these fully multi-user? Are they integrated with the chat, whiteboard, graphical referencing, history and Replayer tools from the VMT Project? Has the extended system been released as Open Source? Are the new features flexible enough to be adapted to math problems and topics in the Cyber-math project?
- *Cyberlearning pedagogy evaluation*: Have mathematical topics been presented, scaffolded, scripted and moderated to support group reasoning about core understandings—from multiple perspectives and representations—of fundamental relationships in algebraic sequences and patterns, combinatorics and probability, social choice and geometry? Have these topics been successful in group usage?
- *Research methodology evaluation*: Has the analysis of chat logs and videotapes been adequate to describe how student groups achieve cognitive accomplishments related to the mathematics they are discussing? Has the project revealed differences in group knowledge building processes between homogeneous and diverse student groups?
- *Theory development evaluation*: Has the theory of group cognition and the understanding of student mathematical reasoning in small groups been significantly extended and deepened as a result of project findings? Specifically, has the use of dynamic math objects and interactive simulations or the involvement of diverse student groups made a difference to these theories?
- *Cyberlearning practice evaluation*: Has our knowledge of the practicalities of designing, supporting, disseminating, and managing cyberlearning sites matured through this project? Specifically, have we learned how to develop cyberlearning for students from diverse backgrounds?

Research Implications

The primary result of the project will be increased insight into how to develop cyberlearning services in STEM fields. The project will demonstrate—using the example of foundational mathematical learning—responses to two specific challenges of cyber learning:

- How to take advantage of computational power of computer-supported communication, namely by providing dynamic math objects and interactive simulations.
- How to adapt cyberlearning to collaboration within small groups consisting of students with diverse backgrounds.

These two features of the Cyber-math Project are synergistic in that the computational support of math reasoning through visual and manipulable representations is hypothesized to aid in establishing common ground. These tools will be integrated with strands of related problems and relevant math informational resources, to help bring all group members to a shared base of understanding.

Like the previous work of the PIs, this project will result in a significant number of academic presentations and publications in journals, conferences and books. However, its broadest influence will be through the provision of online services at the Math Forum. The Cyber-math project will establish an on-going service at the Math Forum, which can serve as a paradigm example of cyberlearning in a STEM field.

It will show how to adapt leading-edge technology to meet the needs of at-risk urban students. Simultaneously, it will provide a model of how cyberlearning can overcome the separation of students from differing backgrounds. It will even take this to the point of bringing students together across national boundaries, providing an opportunity for international cultural understanding.

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a. Professional Preparation

Undergraduate

Hampshire College Mathematics and Statistics B.S. 1976

Graduate

University of Michigan Mathematics M.S. 1977

Rutgers University Mathematics Education Ph.D. 2003

b. Appointments

Rutgers University Robert B. Davis Institute for Learning
Graduate School of Education Associate Director 2003-Present

Rutgers University Department of Urban Education
Newark College of Arts and Sciences Associate Professor 1987-Present

Rutgers University Department of Academic Foundations
Newark College of Arts and Sciences Assistant Professor 1981-1987

c. Selected Publications

1. **Powell, A. B.**, & Lai, F. F. (in press). Inscription, mathematical ideas, and reasoning in VMT. In G. Stahl (Ed.), *Studying Virtual Math Teams*. New York: Springer.
2. **Powell, A. B.**, Borge, I. C., Floriti, G. I., Kondratieva, M., Koublanova, E., & Sukthankar, N. (in press). Challenging tasks and mathematics learning. In P. J. Taylor & E. J. Barbeau (Eds.), *Challenging mathematics in and beyond the classroom*. New York: Springer.
3. Matos, J. F., **Powell, A. B.**, & Stzajn, P. (in press). Mathematics teachers' professional development: Learning in and from practice. In D. L. Ball & R. Even (Eds.), *The professional education and development of teachers of mathematics*. New York: Springer.
4. Weber, K., Maher, C., **Powell, A. B.**, & Stohl Lee, H. (2008). Learning opportunities from group discussions: Warrants become the objects of debate. *Educational Studies in Mathematics*, 68(3), 247-261.
3. **Powell, A. B.** (2007). Caleb Gattegno (1911-1988): A famous mathematics educator from Africa? *Revista Brasileira de História da Matemática*, 199-209.
4. **Powell, A. B.**, & Bairral, M. A. (2006). *A escrita e o pensamento matemático: Interações e potencialidades [Writing and mathematical thinking: Interactions and potentialities]*. Campinas, São Paulo: Papirus
5. **Powell, A. B.** (2006). Socially emergent cognition: Particular outcome of student-to-student discursive interaction during mathematical problem solving. *Horizontes*, 24(1), 33-42.
6. **Powell, A. B.**, & Hanna, E. (2006). Understanding teachers' mathematical knowledge for teaching: A theoretical and methodological approach. In J. Novotná, H. Moraová, M. Krátká & N. a. Stehliková (Eds.), *Proceeding of the 30th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 369-378). Prague: Charles University.
7. **Powell, A. B.**, Francisco, J. M., & Maher, C. A. (2003). An analytical model for studying the development of mathematical ideas and reasoning using videotape data. *Journal of Mathematical Behavior*, 22(4), 405-435

d. Synergistic Activities

i. Co-PI on NSF grant (MDR-9053597), "Research on Informal Mathematics Learning," investigating characteristics of mathematics learning and its facilitation in an informal, after-school, and urban environment. The project consists of two interconnected studies. The first focuses in-depth on (1) the mathematical ideas and forms of mathematical reasoning that middle-school students develop and use as they investigate well-defined, open-ended tasks; (2) the

patterns of discourse among the students as they build solutions to each task; and (3) over the course of the study, changes that occur in students' views about mathematics and about themselves as mathematical thinkers. The second study documents and analyzes facilitator interventions and their consequent influence on student-to-student discursive interactions and individual student learning. The two studies employ curricular materials, a pedagogical approach, as well as methodological and analytic tools developed at the Robert B. Davis Institute for Learning. The setting for both studies is an informal after-school program for students of Hubbard Middle School in Plainfield, which is an economically depressed, urban school district with a population of 98% African American and Latino students.

ii. Have designed and lead professional development activities for practicing teachers in New Jersey (including Newark, Plainfield, Englewood, and New Brunswick), in The Bronx, New York City, and in other urban districts in other regions of the United States as well as in other parts of the world (Canada, China, Mozambique, South Africa, and Brazil).

iii. Have develop and implemented courses for prospective teachers in the areas of mathematics pedagogy, mathematics teaching with technology, and problem solving in teaching secondary-school mathematics.

e. Collaborators & Other Affiliations

i. Collaborators (last 48 months)

Bairral, Marcelo Almeida, Universidade Federal Rural do Rio de Janeiro (Brazil)

Chazan, Dan, University of Maryland, College Park (USA)

D'Ambrosio, Ubiratan, Universidade Estadual De Campinas (Brazil)

Domite, Maria do Carmo, Universidade de São Paulo (Brazil)

Dörfler, Willi, Universität Klagenfurt, (Austria)

Driscoll, Mark, Education Development Center (USA)

Fantinato, Maria Cecilia, Universidade Federal Fluminense (Brazil)

Frankenstein, Marilyn, University of Massachusetts-Boston (USA)

Gerdes, Paulus, Universidade Pedagógica, Maputo, (Mozambique)

Greer, Brian, Portland State University (USA)

Janete Bolite Frant, Universidade Bandeirante de São Paulo (Brazil)

Julie, Cyril, University of the Western Cape (South Africa)

Nemirovsky, Ricardo, San Diego State University (USA)

Maher, Carolyn A., Rutgers University (USA)

Stahl, Gerry, Drexel University (USA)

Weber, Keith, Rutgers University (USA)

ii. Graduate and Postdoctoral Advisors

Maher, Carolyn A., Rutgers University

Brown, Morton, University of Michigan

iii. Thesis Advisor and Postgraduate-Scholar Sponsor

Marcelo A. Bairral (post-doctorate advisor)

Evelyn Hanna, (doctorate, 2007)

Feng-Yin Franklin Lai

Kevin Merges

Kate O'Hara

iv. Graduate Students worked with:

Evelyn Hanna (2007)

Mark S. Jacobs (2007)

Antônio Olímpio Junior (2006)

Sumaia Aparecida Curry Vazquez (2004)

Larry D. Kannemeyer (2003)

f. Courses taught past 3 years

Mathematics and Instructional Technology (undergraduate), Information and Communication Technology in Secondary Schools (undergraduate), Mathematical Problem Solving, (undergraduate honors), Research into the Development of Mathematical Ideas (graduate), Qualitative Research Methods I (graduate),), Qualitative Research Methods II (graduate), and Video Data Methodology (graduate).

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Gerry Stahl teaches, publishes and conducts research in human-computer interaction (HCI) and computer-supported collaborative learning (CSCL). His new book, *Group Cognition: Computer Support for Building Collaborative Knowledge* is published by MIT Press. 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 large 5-year 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 at the I-School of Drexel.

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

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. (2006). Group cognition in an online chat community: Analyzing collaborative use of a cognitive tool. *Journal of Educational Computing Research (JECR) special issue on Cognitive tools for collaborative communities*. Available online at <http://www.cis.drexel.edu/faculty/gerry/pub/jecr.pdf>.
- Stahl, G. (2006). Sustaining group cognition in a math chat environment. *Research and Practice in Technology Enhanced Learning (RPTEL)*, 1 (2). Available online at <http://www.cis.drexel.edu/faculty/gerry/pub/rptel.pdf>.
- Stahl, G. (2006). Analyzing and designing the group cognitive experience. *International Journal of Cooperative Information Systems (IJCIS)*. Available online at <http://www.cis.drexel.edu/faculty/gerry/pub/ijcis.pdf>.
- Stahl, G. (2005). Group cognition in computer assisted learning. *Journal of Computer Assisted Learning (JCAL)*. Available online at <http://www.cis.drexel.edu/faculty/gerry/publications/journals/JCAL.pdf>.
- Stahl, G., Rohde, M., & Wulf, V. (2006). Introduction: Computer support for learning communities. *Behavior and Information Technology (BIT)*. Available online at http://www.cis.drexel.edu/faculty/gerry/pub/bit_intro.pdf.

Other Publications

- Stahl, G. (2006). *Group cognition: Computer support for building collaborative knowledge*. Cambridge, MA: MIT Press. Available online at <http://www.cis.drexel.edu/faculty/gerry/mit/>.
- 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 Associates Available online at <http://isls.org/cscl/cscl2002proceedings.pdf>.
- Stahl, G. (2005). *Groups, group cognition & groupware [keynote]*. Paper presented at the International Workshop on Groupware (CRIWG 2005), Racife, Brazil. Available online at <http://www.cis.drexel.edu/faculty/gerry/pub/criwg2005.pdf>.
- 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. Available online at <http://www.cis.drexel.edu/faculty/gerry/publications/presentations/delfi>.

Synergistic Activities

- 2007-2008: “*Exploring Adaptive Support for Virtual Math Teams*.” (co-PI with PI Carolyn Rose) \$50,000; sponsor: NSF SGER.
- 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.
- 2003-2008: “*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.
- 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).

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, K. Ann Renninger, Wesley Shumar, Stephen Weimar, Alan Zemel (Drexel U., Philadelphia); Timothy Koschmann (Southern Illinois U.); Angela Carell, Thomas Herrmann, Andrea Kienle, Ralf Klammer, Kai-Uwe Loser, Wolfgang Prinz, Markus Rohde, Volker Wulf (Germany); Sten Ludvigsen, Anders Morch, Barbara Wasson (Norway), Cesar Alberto Collazos (Chile); Jan-Willem Strijbos (Netherlands). Carolyn Rose (CMU), Daniel Suthers (Hawaii), Sharon Derry (Wisconsin), Mary Marlino (UCAR)

Dissertation Advisors: Gerhard Fischer, Clayton Lewis, Raymond McCall, Mark Gross (U. Colorado, Boulder). Samuel Todes, Theodor Kiesel (Northwestern).

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, Johann Sarmiento, Ramon Toledo, Jim Waters, 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 (Politechnica University of Bucharest, Romania); Angela Carell (Bochum U., Germany); Martin Wesner, Martin Mühlpfordt (FhG-IPSI, Germany); Elizabeth Charles (Canada), Weiquin Chen (Norway).

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www.gepeticem.ufrj.br

Professional Experience
UFRRJ, Institute of Education

SENIOR SCIENTIST 1997-PRESENT

Formation

- Federal Fluminense University-UFF. Licentiate in Mathematics, 1990.
- Federal Fluminense University-UFF. Post-graduate studies in Mathematics, 1992.
- Santa Úrsula University-USU. Master studies in Mathematics Education, 1996.
- Barcelona University, Doctor in Mathematics Education, 2002.

Visiting scholar

2006-2007: Rutgers, Rutgers, The State University of New Jersey, Newark
Department of Urban Education (Brazilian Ministry of Education/Capes grant BEX 1313/06-1)

Funded Research

- Professional Teacher Development in Distance Learning Programs (Ministry of Education/CAPES grant BEX1855/99-9, Ministry of Education/SESu, grant 321/2003 and 277/2004).
- Geometry for 11-14 years old students' through Internet (FAPERJ: Foundation to Research Support of State of the Rio de Janeiro, grant E-26/170.492/2004).
- Digital Inclusion of Youth and Adults (Ministry of Education/SESu grant 293/2005).
- Students interactions and mathematic learning within virtual environments (National Council of Technological and Scientific Development/CNPq grant 311245/2006-4).
- Discourse and mathematic learning of high-school students in virtual environments (Ministry of Science and Technology/CNPq grant 478985/2006-1).
- Professional development, technological mediation and mathematical learning (Rio de Janeiro, Faperj Foundation; E-26/111.182/2008).

Selected Publications

Bairral, M. A. (2007). Building a community of practice to promote inquiry about geometric: A study case of pre-service teachers interacting online. *Interactive Educational Multimedia*(14), 40-53

Bairral, M. A. (2005a). Alguns contributos teóricos para a análise da aprendizagem matemática em ambientes virtuais. *Paradigma*, 26(2), 197-214.

Bairral, M. A. (2005b). Debate Virtual y Desarrollo Profesional. Una Metodología para el Análisis del Discurso Docente. *Revista de Educación*(336), 439-465.

Bairral, M. A. (2004a). Compartilhando e Construindo Conhecimento Matemático: Análise do Discurso nos Chats [Sharing and constructing mathematical knowledge: Discourse analysis of chats]. *BOLEMA: O Boletim de Educação Matemática [BOLEMA: The Bulletin of Mathematics Education*, 17(22), 37-61.

Bairral, M. A. (2004b). Virtual Interactions, shared teacher's meanings and geometric hypertextual tasks. In J. Giménez, G. E. FitzSimons & C. Hahn (Eds.), *A challenge for mathematics education: To reconcile commonalities and differences* (pp. 288-293). Barcelona: Graó.

Bairral, M. A. (2003a). Aprender a Aprender Geometría en Entornos Virtuales. Análisis de Significados Docentes sobre la Noción de Medida. *Educação Matemática Pesquisa*, 5(2), 81-103.

- Bairral, M. A. (2003b). Dimensões de Interação na Formação a Distância em Matemática [Dimensions of interaction on the mathematic training at distance]. *Perspectiva*, 27(98), 33-42.
- Bairral, M. A. (2002). *Desarrollo Profesional Docente en Geometría. Análisis de un Proceso de Formación a Distancia [Teacher Professional Development in Geometry. Analysis of a Distance Training Process]*. Unpublished Doctoral Thesis, Barcelona University, Barcelona.
- Bairral, M. A., & Di Leu, R. (2007). Relato de uma contribuição de futuros professores de matemática com a inclusão digital de jovens e adultos (Report of the contribution of pre-service mathematics teachers within digital inclusion of youth and adults). *Perspectiva*, 31(115), 117-128.
- Bairral, M. A., & Freitas, I. (in press). Argumentar é Preciso! O Fórum Virtual como Espaço de Discussão na Formação Inicial de Professores de Matemática. *Movimento*, 14.
- Bairral, M. A., & Giménez, J. (2004). *Geometria para 3º e 4º ciclos pela Internet (Geometry for 11-14 years old students' through Internet)*. Seropédica, RJ: Educ.
- Bairral, M. A., & Giménez, J. (2003). *On line professional community development and collaborative discourse in geometry*. Paper presented at the Joint Meeting of PME and PMENA at Honolulu.
- Bairral, M. A., & Powell, A. B. (2008). *Analysing High School Students Interacting at Distance with VMT-Chat on Taxicab Problem*. Paper presented at the II SIPEMAT, Recife.
- Bairral, M. A., Powell, A. B., & Santos, G. T. d. (2007). Análise de interações de estudantes do Ensino Médio em chats [Analysis of high school students' online chat interaction]. *Educação e Cultura Contemporânea (Education and Contemporary Culture)*, 4(7), 113-138.
- Bairral, M. A., & Zanette, L. R. (2005). *Geometric learning and interaction in a virtual community of practice*. Paper presented at the Fifteenth ICMI Study Group "The Professional Education and Development of Teacher of Mathematics".
- Dumont, A. H., & Bairral, M. A. (in press). Um estudo com professoras ensinando poliedros e corpos redondos em sua turma de 4ª série. *Acta Scientiae*, 10(1).
- Giménez, J., & Bairral, M. A. (2004). *Frações no Ensino Fundamental: Conceituação, Jogos e Atividades Lúdicas (Vol. 2)*. Seropédica, RJ: Educ.
- Giménez, J., Rosich, N., & Bairral, M. A. (2001). Debates Teletutorizados y Formación Docente. El caso de "Juegos, Matemáticas y Diversidad" [Teletutorized Debates and Teacher Training. The case of "Games, Mathematics and Diversity"]. *Revista de Educación*, 326, 411-426.
- Lemos, W. G., & Bairral, M. A. (2008). Recursos na internet e dobraduras para poliedros estrelados: uma proposta para o trabalho no ensino médio (Internet resources and origami for stellar polyhedra: a proposal for teaching in high school). *Revista Brasileira de Ensino de Ciência e Tecnologia*, 1(2), 38-57.
- Powell, A. B., & Bairral, M. A. (2006). *A escrita e o pensamento matemático: Interações e potencialidades*. Campinas, SP: Papirus.

Other Activities

- Designer of virtual environments to enrich the E-learning of mathematics: www.gepeticem.ufrj.br
- Editor of the Bulletin *GPEM* (ISSN-0104-9739)
- Reviewer of the following Journal: *Zetetiké* and *Research in Science Education (Brazil)*, *Paradigma* (Venezuela), and *Quadrante* (Lisbon).
- Reviewer of Annual Meeting of the National Association of Research in Education (ANPEd), Brazil.
- Vice-coordinator of workgroup of Mathematics Education (WG19) from ANPEd (2008-2009).

Collaborators in the past 48 Months

- Arthur B. Powell, Rutgers University (USA)
- Joaquin Giménez, Barcelona University (Spain)

FENG-YIN FRANKLIN LAI
Rutgers, The State University of New Jersey
110 Warren Street
Room 178
Newark, NJ 07102
Tel: 908-353-3538
E-mail: f.frank.lai@gmail.com

a) Professional Preparation

Graduate

Rutgers University Mathematics Education Ed.D., Presently enrolled

Undergraduate

Columbia University Computer Science B.S. 2003

b) Appointments

Rutgers University Part-time Lecturer 2007 – Present

Rutgers University Metromath Graduate Fellow 2004 – 2006

c) Publications

1. Powell, A. B., & **Lai, F. F.** (in press). Inscriptions, mathematical ideas and reasoning in VMT. In G. Stahl (Ed.), *Studying Virtual Math Teams*. New York: Springer.
2. **Lai, F. F.** (2006). Inter-student questioning in students' investigations into algebra: a dialogue between kianja and jerel. In S. Alatorre, J. L. Cortina, M. Sáiz & A. Méndez (Eds.), *Proceedings of the Twenty Eighth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. Mérida, Mexico: Universidad Pedagógica Nacional.

d) Graduate Advisor

Powell, Arthur B., Rutgers University (USA)

e) Collaborators & Other Affiliations

Bairral, Marcelo Almeida, Universidade Federal Rural do Rio de Janeiro (Brazil)

Cakir, Murat, Drexel University (USA)

Merges, Kevin, Rutgers Preparatory School (USA)

O'Hara, Kate, Long Branch High School (USA)

Powell, Arthur B., Rutgers University (USA)

f) Courses taught past 3 years

Elements of Algebra (undergraduate), Mathematics and Instructional Technology (undergraduate)

George Mathew

Mathforum
Drexel University
Philadelphia, PA 19104

215-895-0933 (office)
gm@mathforum.org

George Mathew designs and architects enterprise Information Systems Infrastructure, teaches, and conducts research in e-collaboration systems. He taught undergraduate and masters courses in programming (JAVA, PERL), software engineering and Mathematics at Penn State University (Abington Campus), Temple University (Main campus) and University of Kerala, India.

Professional Preparation

University of Kerala, India	Mathematics	B.Sc 1977
University of Kerala, India	Mathematics	M.Sc 1979
Indian Institute of Technology, Bombay, India	Computer Science	M.Tech 1987

Appointments & Professional Experience

2008-present	Director of Information Technology Goodwin College of Professional Studies Drexel University, Philadelphia, PA
2006-2008	Chief Technology Architect Fox Chase Cancer Center Philadelphia, PA
2002-2006	Director of Technical Services Fox Chase Cancer Center Philadelphia, PA
1998-2002	Manager of Systems and Applications Fox Chase Cancer Center Philadelphia, PA
1994-1998	Sr. Systems Administrator Fox Chase Cancer Center Philadelphia, PA
1991-1994	Sr. Software Engineer Fischer and Porter Co. Warminster, PA
1989-1991	Software Engineer Liberty Technologies Conshohocken, PA
1980-1989	Lecturer in Mathematics Mar Thoma College (Affiliated with Mahathma Gandhi University) Kerala, India
1994-1998	Jr. Lecturer in Mathematics Bishop Moore College (Affiliated with University of Kerala) Kerala, India

Relevant Publications

- Mathew, G. (2008). "An opensource collaboration tool for course works". Poster for Mid-Atlantic Regional Conference of Educause, Baltimore, MD
- Mathew, G. (2007). "Policy and Governance in Secure Collaboration: based on caBIG experiences", Advanced CAMP NMI-EDIT, Portland, OR
- Robbins, R., Crowley, R., Weems, W., Whitney, D., Ransom, M., **Mathew, G.**, Manion, F. (2007). "caBIG Data Sharing and Intellectual Capital Workspace Information Security: white paper on Technical Implications".

Other Publications

Mathew, G., Ross, E., Manion, F., Collins, M., Beck, R. (2008). "*Enterprise-wide authentication and authorization strategies for translational research informatics*" AMIA 2008, San Fransisco, CA

Ochs, M., Goralczyk, E., Grant, J., Tchuvatkina, O., Manion, F., Yeung, A., Seeholzer, S., **Mathew, G.**, Hardy, R., Beck., R. (2004). "A Unified Laboratory Information Management System for Research Data" Poster in Medinfo, San Francisco, CA

Synergistic Activities

- 2005-2006: "*Pilot Testing of Shibboleth Federation concept*". Pilot test between Fox Chase Cancer Center, Philadelphia, PA and Fred Hutchinson Cancer Center, Seattle, WA
- 2001-2002: "*Design of the architectural components of flowcytometry LIMS*". Dr. Michael Ochs
- 2004-2005: "*Design and architect the integration of Radiance 2000 LSCM and LaserSharp analysis software for Cell Imaging Facility*". Dr. Sandra Jablonski
- 2003-2004: "*Integration of Digital Image data from VoxelQ*". Dr. Alan Pollack.

Collaborators & Other Affiliations

Collaborators : J. Robert Beck, Frank J. Manion, Eric Ross, George Doug Markham (Fox Chase Cancer Center), Michael Ochs (Johns Hopkins University), Sandra Jablonski (Georgetown University), Alan Pollack (University of Miami), William Weems (University of Texas Health Science Center), Robert Robbins (Fred Hutchinson Cancer Center)

Graduate Advisors: S. L. Mehndiratta (IIT, Bombay), John Nosek (Temple University)

Stephen Andrew Weimar
Director of the Math Forum @ Drexel

Address: The Math Forum @ Drexel
3210 Cherry Street
Philadelphia, PA 19104
215-895-0236

PROFESSIONAL PREPARATION

Haverford College

Philosophy

B.A., 1980

APPOINTMENTS

Director, The Math Forum @ Drexel, Drexel University (2001-present): Responsible for research and business development, operations, and program design of the 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. (1993-2005). *The Math Forum* <http://mathforum.org/>

Renninger, K. A., Weimar, S. A., & Klotz, E. A. (1998) Teachers And Students Investigating And Communicating About Geometry: The Math Forum. In R. Lehrer and D. Chazan (Eds.), *New Directions in Teaching and Learning Geometry*. Hillsdale, NJ: Lawrence Erlbaum Associates.

SYNERGISTIC ACTIVITIES

Co-Principal Investigator, *Customized Resources for NSDL*, a collaboration with Beverly Woolf at the University of Massachusetts to provide instructional middleware

that will solicit teacher/student input about learning needs and characteristics, personalize instruction for individual an student, based on cognitive, affective and social characteristics, and grade the effectiveness of the resource.

Co-Principal Investigator, Virtual Math Teams, a collaboration with Gerry Stahl in the Drexel College of Information Science and Technology investigating effective environments for online mathematics problem-solving in groups. A key goal is to develop scalable systems to support student participation in and learning from the Problem of the Week.

Co-Principal Investigator, Web Math Communication, a collaboration with Krandick and others in the Drexel Department of Computer Science investigating strategies for improving students' and mentors' reuse of prior questions and answers, along with tools to enhance mathematical communication and exploration.

COLLABORATORS & OTHER AFFILIATIONS

Agogino, Alice, U. Cal. Berkeley
Albers, Donald, Math. Assoc. of America
Awerbuch, Jonathan, Drexel University
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

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Rutgers University Newark				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Arthur B Powell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. Arthur B Powell - Principal Investigator	0.00	2.77	1.00	\$	29,613	\$	
2. Marcelo Bairral - Co-PI	0.00	0.00	0.00		0		
3. Feng-Yin F Lai - Project Director	6.00	0.00	0.00		24,000		
4. Gerry Stahl - Co-PI	0.00	0.00	0.00		0		
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00		0		
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	2.77	1.00		53,613		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00		0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00		0		
3. (1) GRADUATE STUDENTS					12,900		
4. (2) UNDERGRADUATE STUDENTS					3,200		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0		
6. (0) OTHER					0		
TOTAL SALARIES AND WAGES (A + B)					69,713		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					21,640		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					91,353		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT					0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					2,500		
2. FOREIGN					3,000		
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$		6,000					
2. TRAVEL		0					
3. SUBSISTENCE		0					
4. OTHER		0					
TOTAL NUMBER OF PARTICIPANTS (6)				TOTAL PARTICIPANT COSTS	6,000		
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES					21,500		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0		
3. CONSULTANT SERVICES					0		
4. COMPUTER SERVICES					0		
5. SUBAWARDS					166,961		
6. OTHER					2,000		
TOTAL OTHER DIRECT COSTS					190,461		
H. TOTAL DIRECT COSTS (A THROUGH G)					293,314		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Facilities & Administrative costs (Rate: 54.5000, Base: 151353)							
TOTAL INDIRECT COSTS (F&A)					82,487		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					375,801		
K. RESIDUAL FUNDS					0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$	375,801	\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME Arthur B Powell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION Rutgers University Newark				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Arthur B Powell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. Arthur B Powell - Principal Investigator	0.00	2.77	1.00	\$ 30,502			
2. Marcelo Bairral - Co-PI	0.00	0.00	0.00	0			
3. Feng-Yin F Lai - Project Director	6.00	0.00	0.00	24,720			
4. Gerry Stahl - Co-PI	0.00	0.00	0.00	0			
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0			
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	2.77	1.00	55,222			
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0			
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0			
3. (1) GRADUATE STUDENTS				13,287			
4. (2) UNDERGRADUATE STUDENTS				3,296			
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0			
6. (0) OTHER				0			
TOTAL SALARIES AND WAGES (A + B)				71,805			
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				22,974			
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				94,779			
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT				0			
E. TRAVEL				2,500			
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							
2. FOREIGN				3,000			
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$	6,000						
2. TRAVEL	0						
3. SUBSISTENCE	0						
4. OTHER	0						
TOTAL NUMBER OF PARTICIPANTS (6)							
TOTAL PARTICIPANT COSTS				6,000			
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES				2,000			
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0			
3. CONSULTANT SERVICES				0			
4. COMPUTER SERVICES				0			
5. SUBAWARDS				155,681			
6. OTHER				2,000			
TOTAL OTHER DIRECT COSTS				159,681			
H. TOTAL DIRECT COSTS (A THROUGH G)				265,960			
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Facilities & Administrative costs (Rate: 54.5000, Base: 110279)							
TOTAL INDIRECT COSTS (F&A)				60,102			
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				326,062			
K. RESIDUAL FUNDS				0			
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$ 326,062			
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Arthur B Powell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION Rutgers University Newark				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Arthur B Powell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. Arthur B Powell - Principal Investigator	0.00	2.77	1.00	\$	31,417	\$	
2. Marcelo Bairral - Co-PI	0.00	0.00	0.00		0		
3. Feng-Yin F Lai - Project Director	6.00	0.00	0.00		25,462		
4. Gerry Stahl - Co-PI	0.00	0.00	0.00		0		
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00		0		
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	2.77	1.00		56,879		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00		0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00		0		
3. (1) GRADUATE STUDENTS					13,686		
4. (2) UNDERGRADUATE STUDENTS					3,395		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0		
6. (0) OTHER					0		
TOTAL SALARIES AND WAGES (A + B)					73,960		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					24,369		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					98,329		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT					0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					2,500		
2. FOREIGN					3,000		
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$		6,000					
2. TRAVEL		0					
3. SUBSISTENCE		0					
4. OTHER		0					
TOTAL NUMBER OF PARTICIPANTS (6)				TOTAL PARTICIPANT COSTS	6,000		
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES					2,000		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0		
3. CONSULTANT SERVICES					0		
4. COMPUTER SERVICES					0		
5. SUBAWARDS					121,843		
6. OTHER					2,000		
TOTAL OTHER DIRECT COSTS					125,843		
H. TOTAL DIRECT COSTS (A THROUGH G)					235,672		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Facilities & Administrative costs (Rate: 54.5000, Base: 113828)							
TOTAL INDIRECT COSTS (F&A)					62,036		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					297,708		
K. RESIDUAL FUNDS					0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$	297,708	\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Arthur B Powell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION Rutgers University Newark				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Arthur B Powell				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. Arthur B Powell - Principal Investigator	0.00	8.31	3.00	\$	91,532	\$	
2. Marcelo Bairral - Co-PI	0.00	0.00	0.00		0		
3. Feng-Yin F Lai - Project Director	18.00	0.00	0.00		74,182		
4. Gerry Stahl - Co-PI	0.00	0.00	0.00		0		
5.							
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00		0		
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	18.00	8.31	3.00		165,714		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00		0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00		0		
3. (3) GRADUATE STUDENTS					39,873		
4. (6) UNDERGRADUATE STUDENTS					9,891		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0		
6. (0) OTHER					0		
TOTAL SALARIES AND WAGES (A + B)					215,478		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					68,983		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					284,461		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT					0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					7,500		
2. FOREIGN					9,000		
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$		18,000					
2. TRAVEL		0					
3. SUBSISTENCE		0					
4. OTHER		0					
TOTAL NUMBER OF PARTICIPANTS (18)				TOTAL PARTICIPANT COSTS	18,000		
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES					25,500		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0		
3. CONSULTANT SERVICES					0		
4. COMPUTER SERVICES					0		
5. SUBAWARDS					444,485		
6. OTHER					6,000		
TOTAL OTHER DIRECT COSTS					475,985		
H. TOTAL DIRECT COSTS (A THROUGH G)					794,946		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)					204,625		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					999,571		
K. RESIDUAL FUNDS					0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					\$ 999,571	\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Arthur B Powell				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification Page

BUDGET JUSTIFICATION

A. SENIOR PERSONNEL

Funding for faculty release time during the academic year and summer salary is requested for Arthur Powell, PI, his efforts with overall project direction, contact with school administrators, supervision of research apprentices, and collaborative research activities, including task design for the Cyber-Math after-school sessions, data analysis and dissemination of findings, with the Co-PIs (Bairral and Stahl). Funding for Co-PI Gerry Stahl is requested through the subcontract to Drexel University (see that budget and justification for details). Funding for Co-PI Marcelo Bairral is requested through the subcontract to the Rural Federal University of Rio de Janeiro (see that budget for details).

Funding is requested for half-time support for the Cyber-Math Project Director, who will work closely with the PI and other Senior Personnel to support planning and design of activities and then will ensure that the research is conducted accordingly. He will coordinate meetings, schedule Cyber-Math after-school sessions, facilitate contact with teacher-researchers at each school site, write and send letters about Cyber-Math after-school activities to student participants and their parents, and collect and maintain project data. He will also manage the project's budget and expenditures, procure supplies, and support other Senior Personnel with preparation of project reports and papers with research findings.

B. OTHER PERSONNEL

Funding is requested for one Graduate Student to work approximately 20 hours per week, calendar year, on data collection and analysis. She will be responsible for videotaping each research session and debriefing discussion that immediately follows it, taking observation notes at each research session, collecting written work from the Cyber-Math sessions, monitoring the high school students' online interactions, contacting The Math Forum staff concerning maintenance issues with VMT-Chat, and assisting in data analysis. Funding is also requested for two Undergraduate Students to work approximately 10 hours per week, academic year, as apprentices in research by providing support to the Graduate Student with her project responsibilities.

Both the project director and the graduate student will use data from this project for their dissertation study.

C. FRINGE BENEFITS

Fringe benefit rates are calculated by type of position and the estimated rates provided by Rutgers SRO vary by year. Rates in year 1 are: 33.5% of academic year salary for faculty and of calendar year salary for full-time staff, 9% on hourly wages, and 0% on faculty summer pay. Rates in year 2 are: 34.5% of annual salary for full-time faculty and staff, 9% on hourly wages, and 0% on faculty summer pay. Rates in year 3 are: 35.5% of annual salary for full-time faculty and staff, 9% on hourly wages, and 0% on faculty summer pay.

D. EQUIPMENT (no funds requested)

E. TRAVEL

Funds requested for domestic travel are for (1) the PI or Co-PI to attend the annual PI meeting in Washington, D.C., (2) dissemination of findings at professional conferences held at locations in North America. Funds requested for foreign travel are for (1) bringing Marcelo Almeida Bairral from Brazil to NJ or sending Arthur B. Powell to Brazil for collaborative research work that cannot be done remotely, and (2) dissemination of findings at professional conferences held at international locations.

Budget Justification Page

F. PARTICIPANT SUPPORT

Participant support funding in the amount of \$1,000 per year for all three years is requested to give each of the 6 teachers who will collaborate on this research. Their contributions to the project will include assistance with recruiting high school student participants, helping the researchers with planning and facilitating the after-school sessions, participating in the debriefings that follow the sessions, and helping to resolve project coordination or implementation issues at the school sites.

G. OTHER DIRECT COSTS

Materials and Supplies funding at a total amount of \$25,500 for the three years is requested to cover the costs of two digital video cameras (\$3,000), three MacBook Pro laptops (\$7,500), computer supplies and software (\$5,000), and videotapes, DVDs, and other project supplies (\$6,000) plus funding for scanning students' work and photocopying costs related to maintaining project records and conducting project work (\$4,000).

The software to be purchased for the two computers includes Microsoft Office, NVivo 8 with full license and software maintenance, and Apple Aperture. The computer supplies include three multifunction printers (one per laptop). Other project supplies include two tripods (one per video camera), and snacks and bottled water to be served to the students before each project session.

All equipment and supplies will be purchased upon funding of this proposal and are to be used expressly for this project. The project director, the graduate student, and the undergraduate student will use the three computers for data collection, analysis, and archival purposes.

The video cameras will be used to videotape the oral assent for each of the students involved and the focus group interviews of the small group teams of students, as well as to take still photos of the students working. Our counterparts in Brazil, South Africa, and Singapore will be providing similar equipment for their use there.

Subcontract funding is to work with Marcelo Almeida Bairral as Co-PI who will collaborate on design, implementation, and analysis of the research and be responsible for overseeing the activities at the Brazilian sites. He will also participate in the publication and dissemination of project findings (see his two page biographical sketch in the Supporting Documents to this proposal).

Subcontract funding is to work with Co-PI Gerry Stahl and the Math Forum Group at Drexel University. The funds include 1 month summer pay for the Co-PI, 2 months calendar year staff support for the Math Forum, fringe benefits on salary, computer-VMT fee, and indirect costs. These costs and their justification are detailed in the Drexel budget.

Other funding is requested in the amount of \$2,000 per year in all three years for the costs of conducting video-conferences for Senior Personnel to work with all the teacher-researchers for planning Cyber-Math activities, discussing task design, and coordinating aspects of implementation among the school dyads formed from the six U.S. and Brazil school sites.

H. INDIRECT COSTS

The Indirect, or Facilities and Administrative (F&A), Cost rate being utilized for this project is the federally approved rate for off-campus research at Rutgers University, which is 54.5% of the Modified Total Direct Cost (MTDC). MTDC equals Total Direct Cost minus Rent for Buildings & Grounds, Participant Support, Permanent Equipment, Tuition, Subcontract Amounts over the first \$25,000 of each Subcontract, and Subcontract Amounts requested for collaborators outside of the United States.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Drexel University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Gerry Stahl				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PP, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. Gerry Stahl - Co-PI	0.00	0.00	1.00	\$	12,901	\$	
2. George Mathew - Research Associate	6.00	0.00	0.00		35,000		
3. Stephen Weimar - Co-PI	2.00	0.00	0.00		19,401		
4.							
5.							
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00		0		
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	8.00	0.00	1.00		67,302		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00		0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00		0		
3. (0) GRADUATE STUDENTS					0		
4. (0) UNDERGRADUATE STUDENTS					0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0		
6. (0) OTHER					0		
TOTAL SALARIES AND WAGES (A + B)					67,302		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					21,672		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					88,974		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT					0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					2,000		
2. FOREIGN					3,000		
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____			0				
2. TRAVEL _____			0				
3. SUBSISTENCE _____			0				
4. OTHER _____			0				
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS					0		
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES					2,000		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					0		
3. CONSULTANT SERVICES					0		
4. COMPUTER SERVICES					7,000		
5. SUBAWARDS					0		
6. OTHER					0		
TOTAL OTHER DIRECT COSTS					9,000		
H. TOTAL DIRECT COSTS (A THROUGH G)					102,974		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Indirect at 50% (Rate: 50.0000, Base: 102974)							
TOTAL INDIRECT COSTS (F&A)					51,487		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					154,461		
K. RESIDUAL FUNDS					0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$	154,461	\$	
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PP NAME Gerry Stahl				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION Drexel University				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Gerry Stahl				AWARD NO.	Proposed	Granted
					NSF Funded Person-months	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. Gerry Stahl - Co-PI				0.00	1.44	1.00
2. George Mathew - Research Associate				3.00	0.00	0.00
3. Stephen Weimar - Co-PI				1.00	0.00	0.00
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)				4.00	1.44	1.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. (0) GRADUATE STUDENTS						
4. (0) UNDERGRADUATE STUDENTS						
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. (0) OTHER						
TOTAL SALARIES AND WAGES (A + B)						61,614
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						19,840
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						81,454
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						2,000
2. FOREIGN						3,000
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____ 0						
2. TRAVEL _____ 0						
3. SUBSISTENCE _____ 0						
4. OTHER _____ 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS						0
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						2,000
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3. CONSULTANT SERVICES						0
4. COMPUTER SERVICES						7,000
5. SUBAWARDS						0
6. OTHER						0
TOTAL OTHER DIRECT COSTS						9,000
H. TOTAL DIRECT COSTS (A THROUGH G)						95,454
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
Indirect at 50% (Rate: 50.0000, Base: 95454)						
TOTAL INDIRECT COSTS (F&A)						47,727
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						143,181
K. RESIDUAL FUNDS						0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ 143,181 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$		
PI/PI NAME Gerry Stahl				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION Drexel University				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Gerry Stahl				AWARD NO.	Proposed	Granted
					NSF Funded Person-months	
A. SENIOR PERSONNEL: PI/PP, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. Gerry Stahl - Co-PI				0.00	0.00	1.00
2. George Mathew - Research Associate				3.00	0.00	0.00
3. Stephen Weimar - Co-PI				1.00	0.00	0.00
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)				4.00	0.00	1.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. (0) GRADUATE STUDENTS						0
4. (0) UNDERGRADUATE STUDENTS						0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6. (0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)						44,215
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						14,680
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						58,895
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						2,000
2. FOREIGN						3,000
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____				0		
2. TRAVEL _____				0		
3. SUBSISTENCE _____				0		
4. OTHER _____				0		
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS						0
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						2,000
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3. CONSULTANT SERVICES						0
4. COMPUTER SERVICES						7,000
5. SUBAWARDS						0
6. OTHER						0
TOTAL OTHER DIRECT COSTS						9,000
H. TOTAL DIRECT COSTS (A THROUGH G)						72,895
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
Indirect at 50% (Rate: 50.0000, Base: 72895)						
TOTAL INDIRECT COSTS (F&A)						36,448
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						109,343
K. RESIDUAL FUNDS						0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ 109,343
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$		
PI/PP NAME Gerry Stahl				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION Drexel University				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Gerry Stahl				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1.	Gerry Stahl - Co-PI			0.00	1.44	3.00	\$ 60,179
2.	George Mathew - Research Associate			12.00	0.00	0.00	72,669
3.	Stephen Weimar - Co-PI			4.00	0.00	0.00	40,283
4.							
5.							
6.	() OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(3) TOTAL SENIOR PERSONNEL (1 - 6)			16.00	1.44	3.00	173,131
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL SCHOLARS			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							173,131
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							56,192
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							229,323
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL							6,000
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							6,000
2. FOREIGN							9,000
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS	\$	0				
2.	TRAVEL		0				
3.	SUBSISTENCE		0				
4.	OTHER		0				
TOTAL NUMBER OF PARTICIPANTS (0)							
TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1.	MATERIALS AND SUPPLIES						6,000
2.	PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3.	CONSULTANT SERVICES						0
4.	COMPUTER SERVICES						21,000
5.	SUBAWARDS						0
6.	OTHER						0
TOTAL OTHER DIRECT COSTS							27,000
H. TOTAL DIRECT COSTS (A THROUGH G)							271,323
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							135,662
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							406,985
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 406,985
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Gerry Stahl				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification Page

BUDGET JUSTIFICATION

A. SENIOR PERSONNEL

The PI, Gerry Stahl, will receive one month of summer salary per year from this project. In addition, in the second and third year of the project he will be released from teaching one course at a fee of 16% of salary in order to pursue research on this project. The PI will be responsible for the over-all direction of Drexel's part of the collaborative project with Rutgers-Newark. This includes research design, analysis and publication. It also includes design of software development.

The co-PI, Stephen Weimar, will receive two months of salary in the first year of the project and one month in the second and third years. The co-PI will be responsible for the integration of project work with Math Forum infrastructure and services. This includes planning for the integration of project software and interventions into the Math Forum service offerings and digital library archives. The co-PI will also provide guidance on math curriculum development and collaborative learning.

Research Associate, George Mathew, will receive a half-time salary from this project in the first and second years and a quarter-time salary in the third year. The RA will be responsible for software development related to the project, including integration of project software with Math Forum software infrastructure. This line item will support other technical staff at the Math Forum, supervised by the RA, as needed. The project requires specialized programming skills, including extending sophisticated Java software and integrating it with the Math Forum servers and infrastructure.

B. FRINGE BENEFITS

The fringe benefit rate for senior personnel at Drexel University is 32.2%.

C. TRAVEL

The project involves staff in Philadelphia, PA, and Newark, NJ, as well as collaborators in Brazil and other locations abroad. In addition, the project involves presentations at national and international conferences. The budget is based upon travel by Drexel personnel to two national sites and two international sites per year. This includes transportation, room, board and conference registrations.

D. SUPPLIES

The project is expected to require \$2,000 annually for general supplies, such as printing toner, paper, office supplies and miscellaneous expenses.

E. COMPUTER USE

The Math Forum charges an annual fee of \$10,000 for projects making extensive use of its servers. This covers the use of servers to run software used by project participants, maintenance, backup, logging and professional advice.

F. INDIRECT COSTS

Drexel University has negotiated a 50% Indirect Cost rate with NSF.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Rural Federal University of Rio de Janeiro				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Marcelo Bairral				AWARD NO.	Proposed	Granted
				NSF Funded Person-months		
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. Marcelo Bairral - Co-PI				3.00	0.00	0.00
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)				3.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. (0) GRADUATE STUDENTS						0
4. (0) UNDERGRADUATE STUDENTS						0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6. (0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)						12,500
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						12,500
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						0
2. FOREIGN						0
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____ 0						
2. TRAVEL _____ 0						
3. SUBSISTENCE _____ 0						
4. OTHER _____ 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS						0
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3. CONSULTANT SERVICES						0
4. COMPUTER SERVICES						0
5. SUBAWARDS						0
6. OTHER						0
TOTAL OTHER DIRECT COSTS						0
H. TOTAL DIRECT COSTS (A THROUGH G)						12,500
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)						
TOTAL INDIRECT COSTS (F&A)						0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						12,500
K. RESIDUAL FUNDS						0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ 12,500 \$
M. COST SHARING PROPOSED LEVEL \$ 0 AGREED LEVEL IF DIFFERENT \$						
PI/PI NAME Marcelo Bairral				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET

YEAR **2**

ORGANIZATION Rural Federal University of Rio de Janeiro				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Marcelo Bairral				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1.	Marcelo Bairral - Co-PI			3.00	0.00	0.00	\$ 12,500
2.							
3.							
4.							
5.							
6.	(0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	0.00	0
7.	(1) TOTAL SENIOR PERSONNEL (1 - 6)			3.00	0.00	0.00	12,500
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1.	(0) POST DOCTORAL SCHOLARS			0.00	0.00	0.00	0
2.	(0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	0
3.	(0) GRADUATE STUDENTS						0
4.	(0) UNDERGRADUATE STUDENTS						0
5.	(0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6.	(0) OTHER						0
TOTAL SALARIES AND WAGES (A + B)							12,500
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							12,500
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL							0
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1.	STIPENDS	\$	0				
2.	TRAVEL		0				
3.	SUBSISTENCE		0				
4.	OTHER		0				
TOTAL NUMBER OF PARTICIPANTS (0)				TOTAL PARTICIPANT COSTS			0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							12,500
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							12,500
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 12,500 \$
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Marcelo Bairral				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG			

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION Rural Federal University of Rio de Janeiro				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Marcelo Bairral				AWARD NO.	Proposed	Granted
					NSF Funded Person-months	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. Marcelo Bairral - Co-PI				3.00	0.00	0.00
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)				3.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. (0) GRADUATE STUDENTS						
4. (0) UNDERGRADUATE STUDENTS						
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						
6. (0) OTHER						
TOTAL SALARIES AND WAGES (A + B)						
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						
2. FOREIGN						
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____ 0						
2. TRAVEL _____ 0						
3. SUBSISTENCE _____ 0						
4. OTHER _____ 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS						
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						
3. CONSULTANT SERVICES						
4. COMPUTER SERVICES						
5. SUBAWARDS						
6. OTHER						
TOTAL OTHER DIRECT COSTS						
H. TOTAL DIRECT COSTS (A THROUGH G)						
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (Rate: , Base:)						
TOTAL INDIRECT COSTS (F&A)						
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						
K. RESIDUAL FUNDS						
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$		
PI/PI NAME Marcelo Bairral				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION Rural Federal University of Rio de Janeiro				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Marcelo Bairral				AWARD NO.			
				Proposed	Granted		
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. Marcelo Bairral - Co-PI				9.00	0.00	0.00	\$ 37,500
2.							
3.							
4.							
5.							
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00	0
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)				9.00	0.00	0.00	37,500
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. (0) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	0
3. (0) GRADUATE STUDENTS							0
4. (0) UNDERGRADUATE STUDENTS							0
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							0
6. (0) OTHER							0
TOTAL SALARIES AND WAGES (A + B)							37,500
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							0
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							37,500
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							0
E. TRAVEL							
1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)							0
2. FOREIGN							0
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____							0
2. TRAVEL _____							0
3. SUBSISTENCE _____							0
4. OTHER _____							0
TOTAL NUMBER OF PARTICIPANTS (0)							
TOTAL PARTICIPANT COSTS							0
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							0
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							0
3. CONSULTANT SERVICES							0
4. COMPUTER SERVICES							0
5. SUBAWARDS							0
6. OTHER							0
TOTAL OTHER DIRECT COSTS							0
H. TOTAL DIRECT COSTS (A THROUGH G)							37,500
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)							
TOTAL INDIRECT COSTS (F&A)							0
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							37,500
K. RESIDUAL FUNDS							0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$ 37,500
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME Marcelo Bairral				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Arthur Powell	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Cyber-math: Developing mathematical reasoning through diverse collaborations	
Source of Support: National Science Foundation Total Award Amount: \$ 999,571 Total Award Period Covered: 09/01/09 - 08/31/12 Location of Project: Rutgers University-Newark, Newark, NJ Person-Months Per Year Committed to the Project. Cal:2.77 Acad: 0.00 Sumr: 1.00	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Gerry Stahl	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Dynamic Support for Virtual Math Teams	
Source of Support: NSF ALT program Total Award Amount: \$ 306,355 Total Award Period Covered: 11/01/08 - 11/01/11 Location of Project: CMU and Drexel Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 2.00	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Marcelo Bairral	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Cyber-math: Developing mathematical reasoning through diverse collaborations	
Source of Support: National Science Foundation Total Award Amount: \$ 999,571 Total Award Period Covered: 09/01/09 - 08/31/12 Location of Project: UFRuralRJ, SeropØdica, Rio de Janeiro, Brazil Person-Months Per Year Committed to the Project. Cal:3.00 Acad:0.00 Sumr: 0.00	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Feng-Yin Lai	Other agencies (including NSF) to which this proposal has been/will be submitted.
<p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: Cyber-math: Developing mathematical reasoning through diverse collaborations</p> <p>Source of Support: National Science Foundation</p> <p>Total Award Amount: \$ 999,571 Total Award Period Covered: 09/01/09 - 08/31/12</p> <p>Location of Project: Rutgers University-Newark, Newark, NJ</p> <p>Person-Months Per Year Committed to the Project. Cal:6.00 Acad: 0.00 Sumr: 0.00</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Summ:</p>	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Stephen Weimar

Other agencies (including NSF) to which this proposal has been/will be

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: The Math Forum's Virtual Fieldwork Sequence

Source of Support: NSF DUE 06536

Total Award Amount: \$498,100

Total Award Period Covered: 9/1/007-8/31/09

Location of Project: Drexel University

Person-Months Per Year Committed to the Project.

Cal: .24

Acad:

Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Catalyzing & Nurturing Online Workgroups to Power Virtual Learning Communities of High-Quality Component-based Educational Software

Source of Support: NSF ITR

Total Award Amount: \$2,299,978

Total Award Period Covered: 9/03-8/09

Location of Project: Drexel University, College of Information Science and Technology

Person-Months Per Year Committed to the Project.

Cal: 2.5

Acad:

Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Leadership Development for Technology Integration

Source of Support: NSF NSDL

Total Award Amount: \$724,709

Total Award Period Covered: 10/05-9/09

Location of Project: Drexel University, The Math Forum

Person-Months Per Year Committed to the Project.

Cal: 1.2

Acad:

Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: The Professional Online Mathematics Learning Network for Teachers

Source of Support: Dept of Ed. - IES

Total Award Amount: 1,500,000

Total Award Period Covered: 2009-2012

Location of Project: Drexel University – School of Education

Person-Months Per Year Committed to the Project. Cal: 1.5 Acad: Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Physics in Philadelphia

Source of Support: NSF: Informal Science

Total Award Amount: 1,677,116

Total Award Period Covered: 2009-2011

Location of Project: Drexel University – School of Education

Person-Months Per Year Committed to the Project. Cal: 2 Acad: Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Dynamic Support for Virtual Math Teams

Source of Support: NSF-ALT

Total Award Amount: \$306,132

Total Award Period Covered: 11/1/08-12/31/2011

Location of Project: Carnegie Mellon University

Person-Months Per Year Committed to the Project. Cal: 1 month Acad: Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Developing mathematical reasoning through diverse collaborations

Source of Support: NSF: REESE

Total Award Amount: \$408,985

Total Award Period Covered: 9/2009-8/2012

Location of Project: Drexel University – IST

Person-Months Per Year Committed to the Project.

Cal: 2

Acad:

Sumr:

Support: Current Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount:

Total Award Period Covered:

Location of Project: Carnegie Mellon University

Person-Months Per Year Committed to the Project.

Cal:

Acad:

Sumr:

FACILITIES, EQUIPMENT, AND OTHER RESOURCES

Laboratory:

Clinical:

Animal:

Computer:

Senior Personnel that will work on this project have laptop and/or desktop computers and basic software to meet their computing needs. The budget for this project includes funds to purchase 3 new MacBook Pro laptop computers to supplement the computer needs of all project personnel. Faculty, students, and staff at Drexel University have access to Microsoft Office 2003, Visual Studio 2005, MS Developer Network, Front Page 2003, Outlook, Visio, SPSS 15 for Windows, Adobe Acrobat 8.0, and SQL server software. For Math Forum information, see Other Resources.

Office:

All personnel participating in this project will use the office infrastructure that supports them in proportion to their effort on the project. The PI at Rutgers University has faculty office space and computer equipment. In addition, the Robert B. Davis Institute for Learning (RBDIL) at Rutgers-Newark, which is adjacent to the PI's office, includes office space for the PI and Project Director at Rutgers University. Office facilities include printing, photocopying and scanning capabilities, as well as secure storage for video data, documents, and all computers, video cameras, and other equipment.

The Co-PI at Drexel University has faculty office space and computer equipment (see computer software information above). Math Forum office space and facilities provided by Drexel University includes a suite of offices, conference room, server room, Internet II access, desktop and laptop computers, copy machine, fax machine, and a printer.

Other:

Rutgers-Newark has a state-of-the-art video conferencing facility that the research team can use for connecting with our Cyber-Math research counterparts in Brazil, where they will use a local video conferencing facility.

MAJOR EQUIPMENT:

The Robert B. Davis Institute for Learning (RBDIL) at Rutgers Graduate School of Education will make its multimedia equipment, including video recording equipment and video editing systems, available to the Cyber-Math project. This will be used to supplement the two video cameras that will be purchased with funds budgeted in through the grant.

OTHER RESOURCES:

The RBDIL will make available materials that have been generated by years of research on the development of students' mathematical thinking, which include open-ended,

problem-solving tasks that span across several mathematical strands.

Drexel University's Information Resources and Technology Department and MathForum.org share the hosting of the Math Forum website. The Math Forum website resides on IBM, Dell, and Penguin hardware. As the MathForum.org hosted Penguin machines are removed from service, new IBM and Dell servers with dual core xeon processors are replacing them.

MathForum.org is transitioning the location of its server suite from the Math Forum offices to the central computing facilities of Drexel University. Drexel University's Information Resources and Technology Department is an enterprise level provider, servicing the information technology needs of more than thirty academic institutions. The physical environment, Internet connectivity, networking, hardware, web servers, and operating systems are monitored 24/7.

The Math Forum website is served using Apache/Tomcat web server software running under the Red Hat Linux operating system. The website applications have been developed using both open-source and commercial tools, with the majority of the site engineered utilizing a java development framework. SQL compliant database engines, including PostgreSQL, MySQL, and Sybase's Adaptive Server Enterprise product, support Math Forum applications. Six of our nineteen servers support a development environment that exactly duplicates our production applications and production database servers, promoting a process for implementing well-vetted software by technical staff and user audience.

November 3, 2008

Dr. Arthur B. Powell
Department of Urban Education
The Robert B. Davis Institute for Learning
Rutgers University
Bradley Hall, Room 156
110 Warren Street,
Newark, NJ 07102

Dear Dr. Powell:

On behalf of Rutgers Preparatory School, I am excited to be a part of this unique partnership between our school and Rutgers University and welcome the opportunity for our students to communicate mathematically with students from high schools in other parts of New Jersey, as well as from three cooperating high schools in Brazil.

I wish to offer my enthusiastic support for the research project, which you are proposing to the REESE program of the National Science Foundation, called "Cyber-Math: Diverse High School Students Developing Mathematical Reasoning through Online Collaboration." From the contact that we have had with your graduate students and you during your pilot project, I have already seen how enthusiastically our students and staff have participated.

This will be a continuation of the pilot project. This year, we have conducted pilot mathematics problem-solving sessions between students at our school and from Long Branch High School (LBHS) in Long Branch, NJ. Our students enjoyed the contact they had with the students from LBHS, and all of the students liked finding out about each other's interests. Furthermore, students from both schools were excited to be engaged in discussions of open-ended mathematics problems, and all of the students look forward to engaging in further discussions. I believe that these pilots greatly benefited our students mathematically, due to the open-ended nature of the problems, as well as enhanced their technological awareness, stemming from their use of various online communication tools to discuss and explore mathematics with their counterparts at LBHS.

Engaging students in collaborating on tasks in small groups develops their ability both to deal with and to find commonality in, a diversity of ideas and simulates the future work environment of our students. More importantly, communicating these ideas to each other is the key to the mastery of mathematical concepts. It is through communication that students can gauge their understanding and openly acknowledge questions that exist in their knowledge base. Communication is a vital, continuous process that both stimulates thought and leads to mastery.

I commend Rutgers University for this initiative and for working with our school. Through this, students will be able to learn different ways of thinking mathematically and to clearly convey their mathematical thinking to others. Your project will help satisfy a serious void in the field of mathematics education. I look forward to continuing our partnership with Rutgers University.

Sincerely,



Stephen Duffy
Upper School Principal



**OFFICE OF THE SUPERINTENDENT
LONG BRANCH PUBLIC SCHOOLS
540 BROADWAY, LONG BRANCH, NEW JERSEY 07740**

JOSEPH M. FERRAINA
SUPERINTENDENT OF SCHOOLS
(732) 571-2868, EXT. 40012
FAX: (732) 229-0797

November 9, 2008

Dr. Arthur B. Powell
Department of Urban Education
The Robert B. Davis Institute for Learning
Rutgers University
Bradley Hall, Room 156
110 Warren Street
Newark, NJ 07102

Dear Dr. Powell:

On behalf of Long Branch High School, I am excited to be a part of this unique partnership between our school and Rutgers University and welcome the opportunity for our students to communicate mathematically with students from high schools in other parts of New Jersey, as well as from three cooperating high schools in Brazil.

I wish to offer my enthusiastic support for the research project, which you are proposing to the REESE program of the National Science Foundation, called "Cyber-Math: Diverse High School Students Developing Mathematical Reasoning through Online Collaboration." From the contact that we have had with your graduate students and you during your pilot project, I have already seen how enthusiastically our students and staff have participated.

This will be a continuation of the pilot project. This year, we have conducted pilot mathematics problem-solving sessions between students at our school and Rutgers Preparatory School (RPS), Somerset, N.J. Our students enjoyed the contact they had with the students from RPS, and all of the students liked finding out about each other's interests. Furthermore, students from both schools were excited to be engaged in discussions of open-ended mathematics problems, and all of the students look forward to engaging in further discussions. I believe that these pilots greatly benefited our students mathematically, due to the open-ended nature of the problems, as well as enhanced their technological awareness, stemming from their use of various online communication tools to discuss and explore mathematics with their counterparts at RPS.

Engaging students in collaborating on tasks in small groups develops their ability both to deal with and to find commonality in, a diversity of ideas and simulates the future work environment of our students. More importantly, communicating these ideas to each other is the key to the mastery of mathematical concepts. It is through communication that students can gauge their understanding and openly acknowledge questions that exist in their knowledge base. Communication is a vital, continuous process that both stimulates thought and leads to mastery.

I commend Rutgers University for this initiative and for working with our school. Through this, students will be able to learn different ways of thinking mathematically and to clearly convey their mathematical thinking to others. Your project will help satisfy a serious void in the field of mathematics education. I look forward to continuing our partnership with Rutgers University.

Sincerely,

Alvin L. Freeman
Principal
Long Branch High School



STATEMENT OF INTENT TO ESTABLISH A CONSORTIUM AGREEMENT

Date: November 13, 2008

Grant Title: Cyber-Math: Developing mathematical reasoning through diverse collaborations

Principal Investigator: Gerry Stahl

Proposed Project Period: 9/1/2009 to 8/31/2012

Proposed Total Amount: \$406,985

The appropriate programmatic and administrative personnel of each institution involved in this grant application are aware of standard consortium grant policy and are prepared to establish the necessary inter-institutional agreements consistent with that policy.

Gerry Stahl
Principal Investigator
Drexel University

Arthur B. Powell
Principal Investigator
Rutgers University

Margaret Vigiolto
Associate Vice Provost
Drexel University

Jacqueline E. Cornelius
Director of Sponsored Programs
Rutgers University

This budget has been approved by the Drexel University Office of Research Compliance and Administration and may not be changed without prior approval by Drexel University.

The PI's signature above certifies that: 1) the information submitted within the application is true, complete and accurate to the best of the PI's knowledge; 2) any false, fictitious, or fraudulent statements or claims may subject the PI to criminal, civil, or administrative penalties; and 3) the PI agrees to accept responsibility for the scientific conduct of the project and to provide the required progress reports if a grant is awarded as a result of the application.



UFRuralRJ - Instituto de Educação
Departamento de Teoria e Planejamento de Ensino
Rodovia BR 465 – km 7
Seropédica – Rio de Janeiro – Brasil
Cep. 23851-970
Telefone/fax: (0055-21) 26821841
mbairral@ufrj.br

Rio de Janeiro, 20 November 2008

Dr. Arthur B. Powell
Department of Urban Education
The Robert B. Davis Institute for Learning
Rutgers University
110 Warren Street
Newark, NJ 07102

Dear Dr. Powell:

It is a pleasure to participate as a Co-Principal Investigator in the research project “Cyber-Math: Diverse High School Students Developing Mathematical Reasoning through Online Collaboration”. This research will be developed in the Department of Urban Education at Rutgers University with Dr. Arthur B. Powell and other investigators. Given my research experience in analyzing the growth of pedagogical content knowledge of teachers engaged in online chat environments, I am particularly interested in collaborating on building a framework for analyzing the online mathematical discussions of small groups composed of high school students. This research is important for understanding how to improve the mathematical reasoning of learners.

Dr. Marcelo Almeida Bairral



Dr. Clifford B. Janey
District Superintendent

Christine Taylor
Principal

**SCIENCE PARK HIGH SCHOOL
THE NEWARK PUBLIC SCHOOLS**

260 Norfolk Street
Newark, New Jersey 07103
(973) 733-8689
Fax (973) 733-8236



Lucille E. Davy
Commissioner of Education

Madison Willis
Dr. Mary Wiggins
Vice Principals

November 20, 2008

Dr. Arthur B. Powell
Department of Urban Education
The Robert B. Davis Institute for Learning
Rutgers University
Bradley Hall, Room 156
110 Warren Street,
Newark, NJ 07102

Dear Dr. Powell:

On behalf of Science Park High School, I am excited to be a part of this unique partnership between our school and Rutgers University and welcome the opportunity for our students to communicate mathematically with students from high schools in other parts of New Jersey, as well as from three cooperating high schools in Brazil.

I wish to offer my enthusiastic support for the research project, which you are proposing to the REESE program of the National Science Foundation, called "Cyber-Math: Diverse High School Students Developing Mathematical Reasoning through Online Collaboration." I believe that this project will greatly benefit our students mathematically, due to the open-ended nature of the problems, as well as enhance their technological awareness, stemming from their use of various online communication tools to discuss and explore mathematics with their counterparts here and abroad.

Engaging students in collaborating on tasks in small groups develops their ability both to deal with and to find commonality in, a diversity of ideas and simulates the future work environment of our students. More importantly, communicating these ideas to each other is the key to the mastery of mathematical concepts. It is through communication that students can gauge their understanding and openly acknowledge questions that exist in their knowledge base. Communication is a vital, continuous process that both stimulates thought and leads to mastery.

I commend Rutgers University for this initiative and for working with our school. Through this, students will be able to learn different ways of thinking mathematically and to clearly convey their mathematical thinking to others. Your project will help satisfy a serious void in the field of mathematics education. I look forward to our partnership with Rutgers University.

Sincerely,

Christina Taylor
Principal, Science Park High School