

USG STEM Initiative
2013-2014 Annual Report
Georgia State University
Submitted by Dr. Dabney Dixon, Coordinator for STEM Education Initiatives

Table of Contents

Overview	1
Budget	1
Program Successes.....	3
Key Projects Appropriate for State-wide Dissemination	4
Challenges in Increasing STEM Degree Production	10
Key Personnel	12
External Grants	13
Mini-grants.....	20

Overview

FY 2014 brought many additional advances in STEM teaching and learning at Georgia State University. We highlight key projects that we feel are now ready to move towards implementation at other institutions and briefly discuss challenges in STEM degree production. University faculty continued with significant external funding in STEM education, both at the University and K-12 levels. A robust mini-grant program allowed a large number of faculty to test curricular improvements. These are listed at the end of this document.

Budget

The amount awarded by the USG system office was \$321,378. GSU added \$51,964 (the required 10% match and additional salary funds) for a final total of \$373,702. All of these funds were in a single account.

Office Salaries. Dabney Dixon oversees the office; half her salary is paid, some by the USG grant and some by the University. Susan Swars provided oversight for work in the College of Education. Staffers included a full-time assistant and a graduate student who performed data analyses.

Faculty Summer Salaries. The most effective inducement for faculty to make significant improvements in their courses is to provide summer salary. We were especially glad to have teams of faculty working on a variety of projects. This encourages faculty to get to know one another better. In addition, when a number of faculty members teaching a course are all involved, the prospect for long-term change improves. The projects are listed at the end of this document.

Graduate Assistants. Many of the projects involved graduate assistants to take and analyze data on curricular improvements. The graduate students are vital in the effort to develop new laboratory experiments, ones that are relevant to the modern student but still teach the necessary fundamentals. Some funds went to graders. We have found that hand-grading homework is far more helpful to the students than any on-line homework programs we investigated (projects in both Mathematics and Chemistry).

Student Assistants. The undergraduate assistants were employed as graders, developers of new laboratory experiments, assistants for the Atlanta Science Festival, and mentors for more junior STEM majors.

Materials and Supplies. We generally use some funds for the STEM Office, and supply limited research funds for faculty without external support who take on undergraduate researchers. These funds were expended as in previous years. The Material and Supplies expenditure was much larger this year because we had planned a significant outlay for Supplemental Instruction. The SI costs were, however, assigned to a different account, and the University did not want to move the funds. We therefore used these funds for the laboratories to help STEM departments update minor equipment and fill out stocks of necessary supplies.

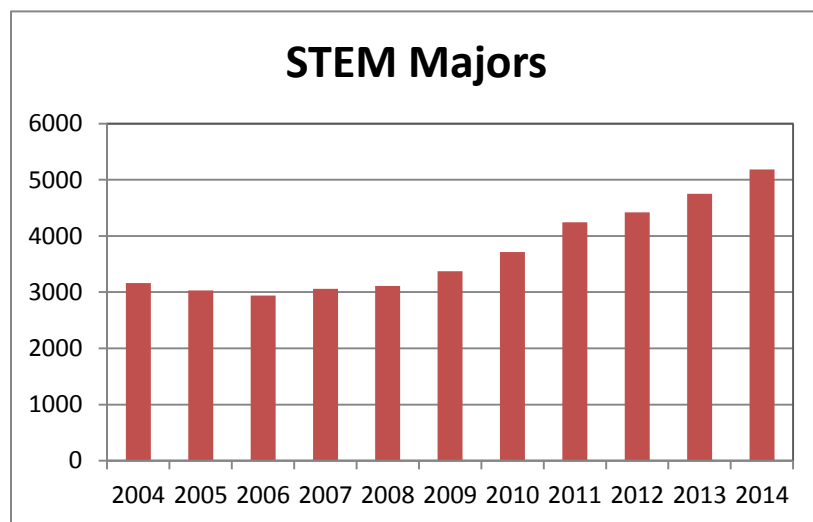
Table. FY 2014 Budget Expenditures.	
Category	Expenditure
Personnel - STEM Office	
Dabney Dixon	\$ 58,585
Susan Swars	\$ 9,147
Office staff	\$ 55,446
Faculty Summer Salaries	\$ 77,134
Graduate Assistants	\$ 71,898
Student Assistants	\$ 16,102
Materials and Supplies	\$ 78,513
Travel	\$ 6,877
Total Costs	\$ 373,702

Travel

Dabney Dixon	Association of Public and Land Grant Universities STEM Centers Director's Meeting	\$895
Christy Visaggi	Regional American Geophysical Meeting	\$537
Kyle Ross	Human Anatomy and Physiology Society (HAPS) Annual Conference	\$675
Katherine Rockwell	Human Anatomy and Physiology Society (HAPS) Annual Conference	\$1109
Dabney Dixon	Third Annual Georgia Scholarship of STEM Teaching & Learning Conference	\$233
Christy Visaggi	Third Annual Georgia Scholarship of STEM Teaching & Learning Conference	\$366
Dabney Dixon	2014 CUREnet Conference on Course-Based Undergraduate Research Experiences	\$544
Pier Junor Clarke	APLU SMTI 2014 National Conference	\$1134
Nermin Bayazit	APLU SMTI 2014 National Conference	\$1384
Total		\$6877

Program Successes

Increased STEM Majors. The data show a significant ~9% increase from FY2013 to FY2014 and



a very large ~67% increase from FY2008 to FY2014. This is due to a variety of factors.

First, the reputation of GSU is growing, and it is rapidly becoming a destination school. Second, our very strong commitment to diversity is attractive to students. As of this year, we rank No.1 in the United States among not-for-profit institutions in awarding bachelor's degrees to African-American students. We rank and 1st in graduation of

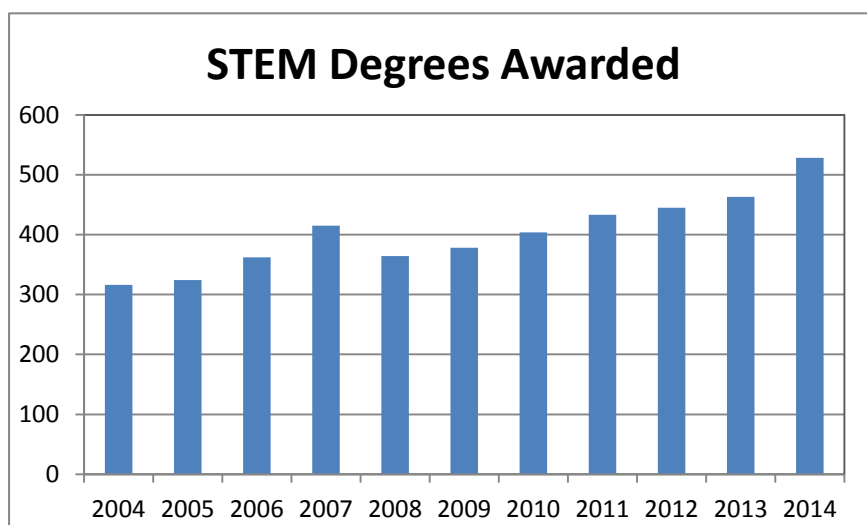
African American students in the Biological and Biomedical Sciences and 3rd in graduation of African American students in the Physical Sciences (Diverse: Issues in Higher Education, 2014). Third, our advising system has been effective in increasing retention and progression. Fourth, USG System funds have given us many opportunities to fine-tune courses to increase retention and progression and students ready for the workforce and professional school. Fifth, our

commitment to high-quality teaching via faculty dedicated to this calling has led to significant attention paid to the details of the STEM courses. Finally, our efforts to create a cadre of strong STEM students to serve as leaders and mentors are bearing fruit.

Increased STEM Degree Completion. Georgia State saw a very significant (~14%) increase in the number of STEM degrees awarded in 2014. These graduation numbers continue to track our number of majors.

Improving Pre-service P-12 STEM Teacher Preparation and Production

The College of Education (COE) at Georgia State has a lengthy and noteworthy history of preparing P-12 STEM teachers as leaders, scholars, and facilitators of change. The COE offers comprehensive programs in many areas of STEM teacher preparation, with an emphasis on innovation and outreach. These programs include alternative preparation pathways for STEM teacher certification, including M.A.T. programs at the middle and secondary levels, in addition to a B.S.E. program in middle level education with a concentration in mathematics and science education. Over the past few years, the COE has added and revised several STEM-related programs. For example, the recent addition of the K-5 Mathematics Endorsement program has resulted in the development of Elementary Mathematics Specialists (EMS) supporting effective mathematics instruction in elementary schools across metro Atlanta. Other relatively recent STEM-related teacher preparation and education program improvements include the: addition of the Georgia ONmyLine Master's in Education Degree in Grades 6-12 Mathematics and Science Education, reactivation of the Bachelor of Science in Education Degree in Middle Level Education with concentrations in mathematics and science education, and addition of the single subject specialty in the Master of Arts in Teaching Degree in Grades 6-12 Science Education. The COE also offers a STEM Freshman Learning Community.



Key Projects Appropriate for State-wide Dissemination

In the section that follows, we highlight specific areas of research that we have developed that are appropriate for dissemination to other institutions in the State. Synopses of all the mini-grants are in the last section of this report.

◆ Undergraduate Students as Learning Mentors

Joshua Von Korff, Suazette Mooring, and Joan Mutanyatta-Comar

Summary of Work. Having undergraduate students take leadership roles benefits them in terms of improving speaking and communication skills, gaining an in-depth knowledge of the material, developing optimal learning strategies, and increasing cohesion in the classroom. We have explored the most effective ways to use undergraduate students and teachers and mentors.

The **Learning Assistant Model** has been used in Physics. The model, first developed at the University of Colorado at Boulder, involves recruiting and training undergraduates to become teaching assistants in an introductory STEM course. Because these undergraduate teaching assistants focus on student learning through Socratic questioning, dialogue, and active engagement, they are called “Learning Assistants,” or LAs. LAs have been used in Physics 1111 and Physics 1112, the introductory algebra-based physics courses. These courses are also the focus of significant teaching enhancements through Dr. von Korff’s NSF WIDER funding. The innovations originally seeded with USG STEM funding also led to a \$300,000 external grant from the PhysTEC, the Physics Teacher Education Coalition, to continue and expand the LA program into GSU’s calculus-based physics courses.

The **Peer-Led Team Learning (PLTL)** model has been implemented in first-semester Organic Chemistry course. Dr. Mutanyatta-Comar put her Friday lectures on line and used the time that had been devoted to lecture in PLTL sessions (approximately 10 students with one undergraduate mentor). Students have reacted very favorably. Students responded positively to the both PLTL and the video recordings. On a five point Likert scale from strongly disagree to strongly agree, students agreed that: 1) attending the PLTL workshops increased their grade (average = 4.22), 2) interacting with other students helped their understanding (average = 4.38) and 3) that their peer leader was well prepared (average = 4.64). An independent t-test was used to compare the American Chemical Society (ACS) Organic Chemistry exam scores of students enrolled in organic chemistry in Spring 2014 (with PLTL-hybrid) with students in the same course, by the same instructor in Spring 2013. The independent t-test showed that there was a statistically significant improvement in the ACS exam scores of students in the PLTL-hybrid course compared to students in the traditional course ($p < 0.05$).

Supplemental Instruction is an academic assistance program that utilizes peer-assisted study sessions. SI leaders are students who have previously done well in the course and can share relevant information, course content and study skills with other students. They act as model students by attending all class lectures and taking notes and then hold SI sessions which are regularly-scheduled, informal review sessions in which students compare notes, discuss readings, develop organizational tools, and predict test items. The SI program has been discussed in detail in previous year’s reports and continues to be a cornerstone of undergraduate mentoring at GSU.

Broader Impacts. As the University System grows and resources tighten, the use of experienced undergraduates as teachers and mentors is a very cost effective approach to help more junior students succeed in their coursework. This strategy has the additional advantage that the very solid foundational knowledge and leadership skills that these undergraduates gain from their work as mentors are important to the success of their careers. Side-by-side comparisons of the successes of different approaches on the same campus with the same

students are vital to understand “what works” so that the most successful approaches can be clearly delineated for the opportunity for expansion to other institutions.

◆ **“3+8” Model of Undergraduate Research: A Partnership between Georgia Perimeter College and Georgia State University**

Al Baumstark, Pamela Leggett-Robinson, Suazette Mooring and Barbara Baumstark

Summary of Work. For the last three years, faculty at GPC and GSU offered an innovative undergraduate research model. GPC students participated in a 3 week (May) research experience program, at GPC, combined with an 8 week research program (June - July) at GSU. Students presented the results of their GPC 3 week program at GPC at the end of the three weeks and the results of their GSU 8 week research projects at the end of July in formal PowerPoint/oral format.

The goals of the program were: (a) to provide the experience and foundation to allow GPC students to successfully make the transition to STEM programs at the 4-year institution and (b) to provide a supportive environment for increased retention, progression and ultimately graduation of STEM majors. Furthermore, STEM graduates with positive undergraduate research experiences will be more likely to attend graduate school and provide the next generation of STEM professionals. Both students and faculty were very pleased with the outcomes. A publication describing the results of this program will be published in the March 2015 edition of *Journal of College Science Teaching*, Leggett-Robinson, P; Mooring, S.R. and Villa B.C. “A 3+8 Model of Undergraduate Research for Community College STEM Major”

Broader Impacts. The 3+8 Undergraduate Research Experience has the ability to introduce a significant number of two-year college students to research experiences. The model is one that can be replicated by multiple institutions.

◆ **Developing Signature Experiences in Research at Georgia State University via the International Genetically Engineered Machine (iGEM) Competition Time and the Undergraduate Research Center**

Matthew Brewer and Paul Ulrich

Summary of Work. Undergraduate research is particularly effective in helping students gain the personal and professional skills that they need to succeed. However, at GSU, fewer than 10% of our STEM majors take advantage of undergraduate research opportunities each year. This is in part because tenure-track (TT) faculty are under increasing pressure to obtain grant funding and therefore reluctant to take undergraduate researchers in quickly increasing numbers. It is also in part because the structure of the University has historically not provided significant support to non-tenure-track (NTT) faculty in terms of course release, laboratory space, or laboratory supplies.

To engage and motivate our students, help them develop high level critical and technical skills, and strengthen our STEM community, we are creating team-based research opportunities through Course-based Undergraduate Research Experiences (CUREs). CUREs

connect groups of ~15 students working under the direction of one faculty member for course credit. These efforts are significantly expanding our current undergraduate research. CUREs help students understand core concepts in the sciences, develop core scientific competencies, and become active contributing members of the scientific community. This project began about four years ago in Biology with the appointment of Dr. Paul Ulrich as Coordinator of the Undergraduate Research Center in that department. The opening of the Petit Science Center allowed space in an older building to be dedicated specifically for undergraduate research (~ 3900 sq. ft. in Kell Hall, centrally located on campus). Large equipment (including a dark room, centrifuges, autoclaves, shakers) was retained in the spaces from the previous funded research use. Small equipment has been provided from University grants, and various sources have been available to fund supplies. In this undergraduate research space, a number of NTT faculty direct small research teams and larger, collaborative research groups (theme-based laboratory courses). Each semester the STEM Office supports about three teams of students. Recent examples include a computational and molecular biology team characterizing mitochondrial proteins (Dr. Paul Ulrich), a joint Biology/Chemistry effort on plant-derived natural products (Drs. Mutanyatta-Comar), and the International Genetically Engineered Machine (iGEM) competition (Dr. Matthew Brewer).

Our goal is for students to personally and professionally develop, cultivate interaction and communication skills, learn to collect and interpret data, understand experimental design and hypothesis development, and synthesize knowledge. This should result in higher retention and graduation rates, increased progression to graduate and professional school, and improve qualification for the workforce. We expect faculty will demonstrate increases in personal development, professional advancement, research productivity, mentoring skills, and willingness to innovate.

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Our goal has been to create a new University model in which NTT faculty provide research opportunities for our students. Course-based Undergraduate Research Experiences (CUREs). To engage and motivate our students, help them develop high level critical and technical skills, and strengthen our STEM community, we are creating team-based research opportunities. CUREs are groups of about 15 students working under the direction of one faculty member for credit in a course. These efforts are significantly expanding our current undergraduate research. CUREs help students understand core concepts in the sciences, develop core scientific competencies, and become active contributing members of the scientific community. This project began about two years ago in Biology with the appointment of Dr. Paul Ulrich as Coordinator of the Undergraduate Research Center in that department. The opening of the Petit Science Center allowed space in an older building to be dedicated

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Broader Impacts. We have created a model of actual research experiences that a) involve teams of undergraduates, b) can be led by faculty who also have very significant teaching responsibilities, and c) can be organized with limited cost to the institution. This model should be widely replicable at other institutions, allowing many undergraduates the opportunity and career-enhancing possibilities of authentic research.

◆ **Training the Teaching Assistants: Creating a Practical Pathway to Expertise**

Dabney Dixon, Debby Walthall, and Kyla Ross

Summary of Work. Undergraduate STEM students in the disciplines of Biology, Chemistry, Geoscience and Neurosciences spend considerable time developing technical expertise in undergraduate laboratories. We are finding that the teaching assistants (both undergraduate and graduate) often do not have the technical expertise necessary to be effective as laboratory TAs. This issue has been the focus of considerable discussion and analysis this year. We have begun putting training modules on-line. We are working to design a system in which TAs are expected to watch the training module and then take an exam on the contents before starting to teach in the laboratories. Creation of good videos is time-consuming. However, once a video is created, it can be very widely used.

Broader Impacts. The approach of more focused and robust training of TAs, especially using on-line resources, can be readily extended throughout the State. In many instances, a single video (e.g., how to use a balance or run a titration) could be used at multiple institutions throughout the University System.

◆ **An Activity-based Integrated Science Course for Future Elementary Teachers**

Marion Reeves and Christy Visaggi

Summary of Work. Better science education in elementary and middle school is vital for the futures of our children. This involves not only a stronger ground in scientific facts and theories, but teaching methods that are effective for engaging students. Integrated Sciences (ISCI 2001, with a focus on Biology and Geosciences) is a required course for students majoring in early childhood education at Georgia State University. A three-year collaboration between the Early Childhood Education Department and the Geosciences Department has allowed for robust development of an activity-based teaching model. Most of the activities in the course have been redesigned. In some instances, presentations formerly done in class have also been flipped so that students work outside of class with the material allowing more use of class time for instructional activities. The sequencing of topics was changed to enhance student understanding of the interrelationship of scientific understanding across these two content areas. The fundamental goal is to move from lectures to inquiry-based activities that allow students to explore foundational concepts in life and earth sciences.

The course uses constructivist approaches in that we are repeatedly using the students' prior knowledge and building on it as the course progresses. We have implemented several exercises that incorporate authentic data collection and interpretation, specifically focusing on their immediate surroundings. For example, obtaining weather data for the campus and region, using maps to interpret their results, identifying "science in action" around GSU (e.g., weathering and erosion of different buildings), and so forth. This has really helped the students realize a) how science is valuable in their lives, b) how science is not scary but can be understood and fun, and c) what they can do in their own classrooms down the road.

Broader Impacts. This model could be very readily extended across Georgia. The types of curricular changes developed are simple and inexpensive replicate at other institutions. Georgia State has four courses of this type, ISCI 2001 (Biology and Geosciences), ISCI 2002 (Chemistry and Physics) and two comparable courses for future middle school teachers. The resources of the Georgia Geographic Alliance (GGA) located at GSU are also available. The GGA is a non-profit organization of individuals who believe that geographic knowledge is essential to the success of our state and nation. The mission is to enhance geographic education and research through the development and promotion of place-based learning opportunities for Georgia K-12 teachers and students across all disciplines especially in Science, Technology, Engineering, and Math (STEM) fields. With this mission, the GGA seeks to ensure that Georgia students, teachers, and community members are global thinkers, geographically-minded problem solvers, and internationally competitive workers.

◆ **STEM FOCUS (Fostering Our Community's Understanding of Science).** The FOCUS program gives undergraduate STEM majors the opportunity to provide support to science teachers and students in area schools while also developing their own teaching skills. At the heart of the program is a service learning experience that provides STEM majors the opportunity to spend three hours per week in a high-needs, urban school setting serving as an instructional support

specialist. FOCUS participants also spend one hour a week in a professional development session designed to improve their pedagogical capabilities in using best practices for teaching science content, with a focus on scientific inquiry and a Learning Cycle Model.

The project's objectives are to:

- Improve the science experiences and science content knowledge of elementary students in the Georgia State University area through pertinent and hands-on science instruction.
- Increase awareness among elementary and middle school students about career opportunities related to the sciences.
- Provide experiences for students and teachers that will bring about more positive attitudes about science as a career choice.
- Improve the content knowledge and confidence of local elementary/middle school teachers and foster sustained, positive changes in how they approach science.
- Develop a sense of community involvement for Georgia State University's student body that will continue after graduation.
- Enhance the communication and leadership skills of participating Georgia State University's students.

Broader Impacts. This program started at the University of Georgia. Initially, it was not successful at Georgia State. However, a number of modifications over the course of the last five years have resulted in a program that is full each semester. The combined expertise of UGA and GSU should allow FOCUS to be expanded to additional institutions, giving more undergraduates who are interested in teaching a chance to evaluate their interest in this career.

Challenges in Increasing STEM Degree Production

Rapid Growth of the University. Many of the challenges in increasing STEM degree production arise from the very rapid growth of the University. We are constantly expanding, which focuses administrative energy on growth, leaving less time for innovation and fine-tuning of programs to match our student's changing needs. Rapid growth results in significant "unmet need", i.e., a situation in which students cannot take the courses they desire in a given semester because there are not enough spaces. We are working on this in a number of ways. (1) As funds are available, we hire new faculty and open new course and laboratory sections. (2) A University-wide program of significantly enhanced advising, with more than 30 new advisors, has helped provide the planning help our students need to graduate in a timely fashion. (3) We are trying to be sure that all STEM departments have up-to-date schedules of their courses on the web for the next two years, allowing students to plan ahead.

Space is a Limiting Factor. Going forward, space will be a limiting factor. The "wet lab" sciences (Biology and Chemistry) are very constrained by space. Some undergraduate laboratories have been moved back into Kell Hall, into space that had been closed upon

construction of the Petite Science Center. A new addition next to Classroom South will provide some wet laboratory space on each of three floors. These changes and new additions will buy us some time, but even more new laboratory space will be necessary, especially if Kell Hall is closed. If students in the experimental sciences are to get STEM jobs (rather than just graduating with a STEM degree), they must have significant laboratory experience, usually in a research setting. Increasingly, we are offering theme-based laboratory experiences led by a lecturer as research experiences. More laboratory space will be needed for these efforts.

Transfer Students at Georgia State. Although Georgia State has many transfer students, these students have not historically been the focus of targeted programs. Some students, overconfident in their preparation, have difficulty at GSU. Our efforts to mentor transfer students have not yet met with significant success. More work is needed in this area. The GSU-GPC merger will bring focus to this area. However, only about a quarter of the STEM transfer students are from GPC, so additional programs will be necessary.

Courses with High DWF Rates. A course with a very high DWF rate slows student progression. In the worst cases, a series of such courses result in a GPA such that the student is no longer eligible for the HOPE scholarship. At Georgia State, students who enter with HOPE and keep it have about a 62% six-year graduation rate. This falls dramatically to only about 22% for students who start with HOPE but lose it. One of the main goals of our program is to reduce the DWF rate in key courses. We have focused on Calculus and Organic Chemistry, nationally regarded as two of the most difficult courses. This is the case at GSU as well. It is important to say here that the funds for these efforts have come directly from the USG STEM program, and the leadership has come from those aligned with this program. Thus, this USG STEM program has made a significant difference in the STEM culture of the GSU.

Student Communities. In the undergraduate STEM education community one often hears “we know what works”: creating a community where students can get to know one another and support one another in studying and in their career aspirations. Seminal work in this area was done by Dr. Philip Treisman, then a professor of Mathematics at the University of California at Berkeley and currently Professor of Mathematics and of Public Affairs at the University of Texas at Austin. He showed that creating a student community had a very significant effect on retention and success for African-American males. Recent work at the University of Baltimore, Maryland County (UMBC), a leader in graduation of successful minority students, has emphasized this point. As a largely commuter institution, GSU faces significant headwinds in creating communities of students who look forward to studying together and supporting one another in their educational endeavors. We continue to work on the issue Supplemental Instruction (focused on creating communities of engaged students), enhanced roles for student clubs, new spaces dedicated to STEM student interactions, and enhanced opportunities for undergraduate research.

Innovative Teaching Methods. All institutions have stellar teachers, who readily impart complex material in a way that interests the students. However, other faculty members continue to use less successful teaching techniques. Classes that are not engaging and

informative lead to students doing more poorly than they would with better teaching. The mini-grant program has allowed faculty to test out new ideas. While a group of faculty members was not a requirement to submit a mini-grant, almost all of the applications did involve more than one faculty member. These teams of people have spent time talking about teaching options and evaluating one strategy with respect to others. This encourages the best teaching strategies to extend throughout the campus.

Key Personnel

Dr. Dabney Dixon, Coordinator of STEM Education Initiatives. Dr. Dixon is responsible for the overall direction of the Office of STEM Education Initiatives. She reports to the Provost's Office and is a liaison to the USG STEM Office, the College of Arts and Sciences, the College of Education, the Honors College, the McNair Scholars Program, the Louis Stokes Alliances for Minority Participation and the SSS-STEM Program (Student Support Services for Science, Technology, Engineering and Mathematics, funded by the Department of Education). She sets the overall direction of the program, arranges the calls for mini-grant proposals and evaluation of the proposals, interacts with a variety of faculty members, including junior faculty just joining the campus, and meets regularly with the various STEM departments and advisors working with STEM students. She continues to encourage data-driven innovations in the area of STEM teaching. Increasingly she is working with other campuses in the region on the synchronization of curriculum and on bringing STEM education innovators here to Georgia to inspire our faculty.

Dr. Susan Swars, STEM Coordinator for the College of Education (COE). Dr. Swars is an Associate Professor of Mathematics Education in the Department of Early Childhood Education and serves as STEM Coordinator for the COE. In this role, she provides support for STEM projects and faculty members in departments across the College, as well as STEM representation for the College at state and national levels. This past year was her second year in this position, and an important goal was the continued development of a unified and coordinated STEM faculty in the COE, with example activities including facilitation of collaborative meetings of all STEM faculty and maintenance of a COE STEM website (with the support of Dustin Butts, Research Associate at Georgia State). In addition, she promoted collaborative relationships between the STEM faculty in the COE and the College of Arts and Sciences, particularly as related to the co-teaching of the Integrated Science Courses for Elementary Teachers. She also supported the FOCUS course implemented by the COE, as well as the Academy for Future Teachers program in the COE. She also participated in the STEM mini-grants program by disseminating related information to the COE faculty and serving on the proposal committee. In addition, she represented the COE at the Science Mathematics Teachers Imperative (SMTI) conference and Mathematics Teacher Education Partnership conference. Examples of other STEM-related efforts she supported this past year include the leadership of Georgia State in the SMTI Mathematics Teacher Education Partnership Program, development and submission of the K-5 Science Endorsement program, and representation of Georgia State on the USG STEM Education Task Force Committee, among other activities.

External Grants

Focused on university students in the STEM disciplines.

National Science Foundation Netzel Scholars: Opportunity in Chemistry and Biology (NSF 0806748; Dr. Dabney Dixon, PI; \$599,474; 9/1/2008–8/21/2015). The goal of this project is to provide support for the highest achieving entering students at Georgia State University declaring majors in chemistry and biology. Many of these students have significant financial needs and thus balance university life, significant work hours, and commuting as they live at home during their university career. These responsibilities make it difficult for them to realize their scholarly potential. S-STEM funds provide scholarships (up to the full FAFSA unmet need) so that the students can live on campus and participate fully in the intellectual and research life of the university (entering classes in 2009, 2010 and 2011). About 10 students are in each cohort. This program not only supports these students financially, but is involved in building infrastructure to enhance the academic and career options of students in these departments.

Chemistry Collaborations, Workshops & Communities of Scholars (cCWCS) (NSF 1022895; Dr. Jerry Smith, PI; \$2,822,709; 2011-2015). This program (www.ccwcs.org) and its predecessors (including the Center for Workshops in the Chemical Sciences) have been located at GSU for over 15 years. The current program emphasizes the development of learning centers to be run primarily by former program participants at the local, regional, and national levels. The effort is a long-standing collaboration with the Georgia Institute of Technology, Millersville University (PA), and Williams College (MA). The Program also offers intensive, five-day workshops on diverse topics in the chemical sciences with the goal of enhancing education, primarily at the undergraduate level. Over the funding period, 2001–2010, the CWCS program has conducted some 103 workshops at 32 diverse locations. The program has attracted 1648 participants from all 50 states plus Guam, Puerto Rico, and Washington, D.C. These participants represent undergraduate faculty from 970 institutions.

The GSU SSS-STEM (Science, Technology, Engineering, and Mathematics) Center for Excellence (Department of Education; Cherryl Arnold, Director; \$1.1 M; 9/1/2010–8/31/2015). This is a program for students pursuing STEM majors who are first-generation college students that demonstrate financial need and/or have documented disabilities. The SSS-STEM Program offers a variety of services and resources to assist these students, including the possibility of grant aid (stipends) for eligible students. Faculty working on the project are Dr. Michael Black (Neuroscience Institute), Dr. Anu Bourgeois (Computer Science), Dr. Gigi Ray (Chemistry), and Dr. Dabney Dixon (Chemistry).

REU Site: Addressing Social and Environmental Disparities through Community Geography and Geographic Information Systems (NSF 1156755; Dr. Timothy Hawthorne, PI; \$350,000; 2/15/2012– 1/31/2015). The six-week summer REU site engages a diverse group of students, faculty and community members in community-based geographic inquiry of social and environmental disparities in Atlanta neighborhoods, including examinations of neighborhood change, property markets, air quality, urban green spaces, and neighborhood visioning. With an

explicit focus on community geography, university-community partnerships and participatory methodologies, the research training program is among the first of its kind for undergraduates in the United States. The REU aims to develop well-prepared, ethical researchers who are committed to community-based research for addressing social and environmental disparities. The site also seeks to develop a new conceptual framework for community geography, an emerging subfield of geography that draws from Participatory GIS (PGIS), mixed methodologies, and critical urban theory.

REU Site: Summer Research for Undergraduates in High Performance Data Mining (NSF 1156733; Dr. Yanqing Zhang, PI; \$309,483; 3/1/2012–2/28/2015). This NSF REU project will provide research opportunities for 8 talented undergraduate students to spend 8 weeks working with four faculty mentors at Georgia State University, an outside faculty mentor from Georgia Tech, two industrial mentors from McAfee and Barracuda Networks, and graduate students. The teams will conduct hands-on research projects in high performance data-mining for bioinformatics and network security. The students will work on research projects to master professional research skills and submit research papers for real publications. Summer activities will include participation in student data mining competitions such as the Data Mining Cup and the UC San Diego Data Mining Contest.

REU Site: Research Experiences for Undergraduates at Georgia State University (NSF 1262743; Suri Iyer and Dabney Dixon, \$286,668, 2013-2015). The REU Site will fund 10 undergraduate students for a 10 week summer research experiences. While the program will be open to students from all states, students will be recruited from local four year and two year community colleges. The proposed activities are expected to advance knowledge in specific projects and allow undergraduates to understand scientific concepts by combining theory and experiment in a research setting. In addition, lectures on diverse topics that include scientific writing and improving presentation skills will prepare the students for scientific careers. The proposed activities are expected to broaden the participation of underrepresented groups as well as economically disadvantaged students. Overall, the proposed activities are beneficial to society because the proposed research activities will not only enhance fundamental knowledge in specific areas, but it is also expected that students participating in this REU program will attend graduate programs and join the scientific workforce.

GAANN (Graduate Students in Areas of National Need) Fellowships (Department of Education; Barbara R. Baumstark, PI with four co-PIs: A.L. Baumstark (Chemistry), G. Davon Kennedy (Chemistry), Donald Hamelberg (Chemistry), Casonya Johnson (Biology), and Charlese Benson (Biology); \$399,798; 8/16/2012—8/15/2015). The Departments of Biology and Chemistry are jointly supported by the Department of Education to provide fellowships to GSU doctoral students who are members of traditionally underrepresented ethnic or racial groups. GAANN Fellows must be U.S. citizens or permanent residents, with specific research interests in biotechnology and/or medicinal chemistry. The GAANN Fellowship requirements include a significant instructional component, which can be fulfilled by participating in GSU's Bio-Bus program, an outreach program that generates enthusiasm for science among K-12 students.

BP-ENDURE-Atlanta: Engaging Undergraduates in Neuroscience Research (NIH 1R25GM097636-01; Dr. Kyle Frantz, PI; \$1.7 M; 2011–2016). This project forms a new Neuroscience Education and Training program (NET/work) for undergraduate students from groups currently underrepresented in the sciences. The program is led by Georgia State University in partnership with Agnes Scott College, Emory University, and Spelman College. The program hires undergraduate students for two years each to join research laboratories at Georgia State or Emory University. Research on program outcomes will test the hypothesis that this type of in-depth research training, coupled with an intensive series of professional development workshops, positively affects communication skills and student confidence in their abilities to do research, and increases matriculation into neuroscience Ph.D. programs.

PhysTEC (Physics Teacher Education Coalition) Grant - Comprehensive Site (Dr. Brian Thoms, PI; \$300K; 8/1/2013-7/31/2016). As a PhysTEC comprehensive site, Georgia State University will become a significant producer of well-qualified, certified physics teachers from diverse racial/ethnic backgrounds through introducing a physics teacher-in-residence program, engaging in a major course redesign in introductory, calculus-based physics which will include tutorials and learning assistants, and undertaking significant new recruiting and mentoring efforts. This work builds on recent efforts at GSU to create multiple pathways through physics teacher preparation including a new concentration in Education within the BS in Physics leading to teacher certification within the four-year undergraduate degree. This new pathway began in Fall 2012 and has already attracted a number of students into physics teaching career paths. This new pathway complements the existing tracks in the Master of Arts in Teaching (MAT) and the BS/MAT. The BS/MAT allows students at GSU or Georgia Tech to accelerate their MAT by taking courses toward the MAT while still undergraduates.

NSF - WIDER Grant – Research – Collaborative Research: Investigating Institutional Success at Overcoming Challenges in Algebra-based Studio Physics. (Dr. Joshua Von Korff, PI; \$500K divided between three collaborating institutions: Georgia State University: \$181K, University of Central Florida: \$156K, George Washington University: \$162K, 1/1/2014-12/31/2016). In a well-known paper, Hake found that instructional strategies utilizing interactive engagement can improve student learning gains. However, the project team's own extensive experience with algebra-based studio physics courses shows that even in a highly interactive classroom, sizable learning gains are not guaranteed. To investigate this problem, we have formed a collaboration of three universities that offer algebra-based studio physics courses. One goal of the project will be to investigate factors that may influence learning gains; another will be to identify model institutions that overcome these challenges. We will begin by examining algebra-based studio physics courses at the three collaborating institutions, performing an in-depth study of our own learning environments. We will then study 12 additional institutions, which will be selected to ensure a diversity of educational settings. By highlighting the particular features of model institutions, we will enable physics educators to improve their students' learning gains as well as increasing their own confidence in the studio method.

NSF – WIDER Catalyzing Transformative Change in the STEM Disciplines at Georgia State University, (NSF 1347609; Dabney Dixon, Kyle Frantz, Suazette Mooring and Anu Bourgeois,

\$249,226, 2013-2015). The goal of this effort is to enhance the educational experience of our majors by encouraging the faculty to make evidence-based changes in their pedagogy. Our first strategy is to assess the current pedagogical knowledge, educational goals, and career motivations of our instructors (including both the tenure-track and a significant number of full-time, non-tenure track faculty). These data will help the University support the faculty in their efforts at pedagogical change. Our second strategy is to assess the data “dashboard” needs of instructional faculty and create readily accessible quantitative data sets to allow rapid assessment of changes in teaching practices. Our third strategy is to provide ideas, expertise and pedagogical help to our faculty via outside mentors. Finally, we will create Faculty Learning Communities (FLCs) that can nucleate change. We expect to significantly increase GSU’s institutional commitment to evidence-based teaching and learning in the STEM disciplines.

Collaborative Research: Real World Relevant Security Labware for Mobile Threat Analysis and Protection Experience (NSF 1244665, Yi Pan, Yanqing Zhang and Michael Weeks, \$60,000, 2013-2016). To address the nationwide demand for incorporating mobile security into computing security education, this project is producing innovative mobile security labware to promote the exposure of students to the concerns of security threats to mobiles and to provide them with hands-on real world relevant mobile threat analysis and protection solutions. The labware helps students to know how a mobile threat and its corresponding protections go into effect. The students experience mobile security knowledge with mobile devices and implement protection apps that are workable in practice. The broader impacts of this project are on the improvements of student learning, educational resources, faculty collaboration and development at three academic institutions in the three states Ohio, Georgia and Tennessee, and the influence on faculties in other institutions. The labware can be integrated into many computer and information security courses and will be made public and disseminated in academic community nationwide to benefit a wide range of universities and colleges that have the need for mobile security education.

Courseware for Improving Undergraduate Students' Debugging Skill in GPU Programming (NSF 1245876; Ying Zhu and Scott Owen, \$174,021, 2013-2016). This project is developing educational materials to help undergraduate computer science students improve their debugging skill in GPU (Graphics Processing Unit) programming. As multi-core processor architecture becomes the norm, undergraduate computer science students need to shift their focus to multi-core parallel programming. GPU programming is an important part of multi-core parallel programming, especially in heterogeneous computing environments that use a mixture of CPUs, GPUs, and other specialty cores. To write GPU programs, students need to learn special programming languages and new debugging skills. The project aims to collect and analyze common mistakes made by novice programmers in GPU programming, apply the educational materials to distributed computing courses and computer graphics courses, and to measure the efficacy of this approach. The educational materials will be shared online with students and instructors and publicize their existence through other online venues such as the ACM SIGGRAPH Education Committee site and print venues such as the IEEE Computer Graphics & Applications Education Department.

Louis Stokes Alliances for Minority Participation (LSAMP) Program (A.L. Baumstark in collaboration with Clark Atlanta University, 9/15/13 to 8/31/18, \$252,505). Dr. A.L. Baumstark coordinates this program at Georgia State; the lead institution is Clark Atlanta University. LSAMP is a fellowship program for undergraduate students majoring in the sciences. The goal is to increase the numbers of minority students who complete the BS degree and enter graduate programs (M.S. or Ph.D.) in the sciences. Approximately 30 fellowships will be awarded. The maximum amount of each award is expected to be \$2,000. Applicants with HOPE scholarships are preferred. Applicants must have non-federal support to be used as matching funds. All qualified undergraduate students (including those who are not minorities) will be considered; preference will be given to upper level students and those carrying out research projects.

Focused on K-12 students and teachers

Network for Enhancing Teacher Quality (NET-Q) (Department of Education; Dr. Gwendolyn Benson, PI; \$13.5M; 2009–2014). NET-Q was developed to meet the challenge of preparing and retaining teachers for the specific demands of teaching high-need subjects in high-need schools in both urban and rural settings. NET-Q is partnered with six metro-Atlanta school systems, four Georgia colleges, Georgia Public Broadcasting, and the National Commission on Teaching and America's Future (NCTAF). NET-Q focuses on effective pre-baccalaureate teacher preparation programs as well as innovative post-baccalaureate programs and residencies. Some of these initiatives include: NET-Q Pathway Scholars which supports teachers and administrators interested in starting or continuing a graduate program at Georgia State University; Teacher Residency program which provides effective pre-service teacher preparation through data-driven graduate degree programs with a year-long apprenticeship that focuses in the subjects of science, math, and special education; and Cross Career Learning Communities that offer a structure for school-based professional learning communities that draws on the expertise of both novice and experience educators.

Impacting Metro Atlanta Science Teaching (I-MAST) (NSF DUE 0934795; Dr. Gwendolyn Benson, PI; \$900K; 6/1/2009–5/31/2014). This is a collaborative effort involving the College of Education and the College of Arts and Sciences at Georgia State University (Georgia State), Georgia Institute of Technology (Georgia Tech), and four high-need school districts (Atlanta Public Schools, Cobb County School District, DeKalb County School System, and Gwinnet County Public Schools) in the Metro Atlanta area. I-MAST is addressing the critical need for high quality science teachers who are prepared for, and committed to, teaching in Metro Atlanta high-need school districts. I-MAST Robert Noyce Scholars are being recruited and selected from the pool of STEM majors from Georgia State and Georgia Tech to pursue secondary science teacher certification via a 5-year Master of Arts in Teaching (MAT) Science program at Georgia State. Selection criteria ensure the participation of underrepresented groups. Twenty-four of these STEM undergraduate majors are receiving 2-year scholarships in their senior year of undergraduate studies and their first year of teacher certification studies. An additional entry point for I-MAST is for STEM graduates interested in changing careers to teaching. Twelve STEM

graduates are receiving one-year scholarships to pursue studies leading to certification and to a MAT degree.

Robert Noyce Urban Mathematics Educator Program (UMEP) Phase II (NSF DUE 1136303; Dr. Christine Thomas, PI; \$149,474; 9/1/11–8/31/14). The Robert Noyce Urban Mathematics Educator Program (UMEP) Phase II is designed to monitor and evaluate the effectiveness of the UMEP that began as a Phase I Noyce Teachers Scholarship program for career changers seeking teaching positions in secondary mathematics. Partnering school districts, the Atlanta Public Schools and the DeKalb County School System are actively engaged in all aspects of the program from selection of UMEP Scholars to the degree program to the placement of UMEP Scholars in teaching positions.

Teaching Teachers Together: Science, Technology, Engineering and Mathematics (DOE U350A110027; Dr. Diane Truscott, Project Director; \$2.1 million; 10/1/11–9/30/16). This program works to recruit teachers into the COE's Urban Accelerated Certification and Master's Program (UACM) who have a passion for teaching science and math. Participants in the program will conduct their field experiences four days a week in Atlanta Public Schools classrooms under the tutelage of mentor teachers, and will have the opportunity to attend professional development seminars and classes that Truscott, Schafer and Williams are developing at a professional learning site. They will also work with graduates of the UACM program in science summer camps beginning in 2013, where children in high-need areas will come to learn about inquiry-based and play-based science.

Atlanta Urban Teacher Residency (AUTR) (Institute of Higher Education Partnership with Atlanta Public Schools, Dr. Mary Ariail, PI; \$277,736, 2012-2015). AUTR helps prepare teachers to teach in Atlanta Public Schools to impact the lives of children in the city of Atlanta. The program focuses on recruiting, preparing and retaining secondary mathematics and science teachers in Atlanta Public Schools. Our mission is to create a pipeline of highly effective secondary teachers in the Atlanta Public Schools' areas of greatest need - math, science, reading, and special education - through an Urban Teacher Residency. As APS seeks to ensure that there is an effective teacher in every classroom, AUTR will prepare an elite cadre of teachers to go into high needs schools. AUTR has identified master teachers to train and support residents as they earn their master's degree and develop their skills as highly effective classroom teachers.

Teaching Teachers Together: Science, Technology, Engineering and Mathematics Success (3-STEMS) (U.S. Department of Education through the Transition to Teaching Program, Diane Truscott, Nancy Jo Schafer and Brian Anthony Williams, \$2,084,507, 2011-2016). The project entitled builds on our current partnership with Atlanta Public Schools and the Urban Accelerated Certification and Master's Program (UACM). The primary goal of the 3-STEMS project is to increase the number of highly qualified teachers committed to high-need urban schools. Project objectives and activities focus on four areas: 1) recruitment and selection; 2) teacher training and certification and endorsement; 3) focus on science, technology, engineering and mathematics (STEM) subjects; and 4) support for new teachers in using data-

based decision-making. In addition to certification in PreK-5, participants will receive an ESOL endorsement during the certification year and a Master's degree in year 2. Participants for certification and endorsements include recent college graduates and mid-career professionals. Project activities include the development of a Professional Learning Site in conjunction with Atlanta Public Schools at one of the partner schools with which we work. This site will serve as a hub for certification and professional learning activities including certification-oriented courses delivered at the school, extensive immersion experiences for TTT interns, STEM demonstration lessons for teachers, and mentorship and coaching for participants. In addition, over the summer, the project will design and implement specialized summer programs for children and teachers in the STEM field. By the end of the project, 3-STEMS will impact 10,125 students and produced 135 newly certified teachers. The project also provides professional learning in STEM for classroom teachers and through our teacher mentor component resulting in support for 405 in-service practitioners.

Verizon Foundation Partnership with The Georgia Geographic Alliance for the Geospatial STEM Academy (Timothy Hawthorne, \$75,000, 2014-2015). The Urban Atlanta Geospatial STEM Academy: Preparing High School Students for Geospatial Technology Careers at Georgia State University (GSU) is a summer STEM education training program that engages one hundred 9th through 11th grade students from the Atlanta region in community-based geospatial technology educational experiences. The Academy offers four separate weeklong summer workshops (25 students per session) where students will apply geospatial technologies to examinations of prominent urban issues, including mapping urban food accessibility; urban green space restoration and non-native invasive species; neighborhood crime statistics and demographics; and multimodal transportation safety analysis. Academy students will engage in active learning connecting interactive lecture discussions, hands-on geospatial technology labs, collaborative research planning discussions, personal and direct mentoring with a diverse group of Georgia State University undergraduate and graduate students, and community-based fieldwork in Atlanta neighborhoods.

DNA is Elementary: Promoting Genetics Literacy (NIH 1R25OD016555, \$1,278,500, Barbara Baumstark, PI and Parjit Kaur, 2014-2019). With funds provided by the Science Education Partnership Award, scientists at Georgia State University (GSU) have created DNA is Elementary, a set of learning modules developed to teach children in grades K through 5 about classical and molecular genetics. In the modules, because of young learners' facility with language acquisition, they are taught by representing DNA as an instructional manual with specific directions for making each unique organism. This project proposes to build on the success with students in the K-5 arena by offering these learning modules to families in an informal science setting. Under the auspices of the Bio-Bus, GSU's mobile laboratory program, the scientists will partner with public libraries to bring activities to children and their families that both educate and entertain. During the summer and on selected weekends and academic holidays, the current series of eight 60-minute modules will be presented at the partner institutions. Families who complete the first four modules will qualify to continue with any of the remaining four modules as well as with new problem-based modules currently under development. Finally, families who wish to become deeply immersed in scientific

experimentation can take part in a metagenomics project involving the identification of novel bacterial sequences from a soil-derived gene library containing over 80,000 clones. The likelihood is high that some of these clones will contain sequences representing species that have never before been reported, thus bringing the excitement of authentic scientific discovery within reach of the families served.

Mini-grants

Metagenomics in the High School Classroom

Investigators: Barbara Baumstark, Parjit Kaur, and Chandan Robbins (Biology)

The Bio-Bus program, an outreach program operated by Georgia State University, has entered into a partnership with Miller Grove High School to provide meaningful scientific experiences for students enrolled in a new STEM Academy. The Bio-Bus will bring learning modules to the high school to augment instruction on topics that fit into the science-intensive curriculum. A special emphasis will be placed on modules covering DNA and genetics. To date, eight 60-minute DNA/genetic sessions have been developed for K-5 students. Following their modification for older students, these sessions will form the foundation for a capstone experience in soil metagenomics. Starting with a genomic library containing over 80,000 clones, students will amplify 16S rRNA gene sequences and determine whether the sequence indicates the presence of a novel organism in the soil sample to be tested. Additional modules will be developed to bridge the information gap between the 8-module series and the metagenomics project. Prior to presentations, Bio-Bus personnel will meet with participating teachers for a preview of the modules. Each module will be piloted with non-Academy students and their feedback will be used to refine the presentations. Results will be disseminated through participation at meetings and posting on the Bio-Bus website.

Preparing Students for Creative Experimentation in Neuroscience

Investigators: Michael Black and Kyle Frantz, Neuroscience Institute, Jeff Boortz and Michael White, School of Art and Design

The Neuroscience Laboratory, with a maximum of 24 students per section, is designed to demonstrate the wonder of discovery while teaching basic research skills in neuroscience. The curriculum is intended to encourage out-of-the-box thinking, as creative development of original experiments expands an existing scientific knowledge base. For many students, this lab is the first in which they are required to go through the whole process of developing a hypothesis, designing the best method to test it, providing preliminary data to test the hypothesis, and troubleshooting protocols when the process does not work as planned. Students present their hypotheses and data in poster format during a research symposium at the end of the semester. This “blank slate” approach has caused some students to report confusion and frustration. We want these students to have a positive STEM experience while

proceeding through the full scientific process in an inquiry-based approach. We believe that advice and/or modeling of behavior by experienced peers in a multi-media awareness and engagement campaign can most effectively help this process. Therefore, we will use a Selected Topics in Graphic Design class to enable Art and Design students to help us create and explore the power of an awareness and engagement campaign across print, linear video, games, and other interactive media to maximize positive student attitudes, engagement, and success. We will use several tools and techniques to analyze which products of the graphic design class are most effective and share these outcomes with other GSU programs that pursue similar exploratory hands-on processes.

The Effects of Using ViSta on Undergraduate Students' Achievement in Statistics and the Role of Cognitive and Non-Cognitive Factors in their Achievement

Investigators: Iman Chahine and Kori Maxwell, Department of Middle and Secondary Education,
Changyong Zhong, Department of Mathematics & Statistics

The proposed project will examine the effects of using visual statistics software on undergraduate students' achievement in Elementary Statistics and the role of cognitive and non-cognitive factors in their achievement. An experimental design will be implemented using ViSta – a visual statistics program. Six sections of the course will be selected and randomly assigned to experimental and comparison groups. The participants (approximately 282 students) will complete four surveys, with pre and posttest measures, which will assess their statistical reasoning abilities, attitudes, self-efficacy, and perceptions of their learning environment. Data will be analyzed using multiple nonlinear regression analysis and Wilcoxon rank statistics.

The Flipped Classroom: How do students view it and does it make a difference in learning?

Investigator: D. Sumith Doluweera, Department of Physics and Astronomy

GSU Department of Physics and Astronomy delivers introductory physics courses using traditional lecture method and reformed SCALE-UP method. However the learning gains measured using standard FCI test remain less than or around 30%. One of the factors that hinder the success of learning may be *"not preparing for the class well."* *Preparing well* means doing the textbook reading assignment and attempting to understand material before the lecture. I propose to investigate the idea of "flipping the classroom" as a pilot project that provide lecture videos instead of just asking student to read the book. In a flipped classroom, the lecture time is replaced with more collaborative learning time involving in- class problem solving. In this study, video lectures will be provided only for selected chapters of the textbook for a selected class, and another similar class done by the same instructor will be taken as a control. A survey will be done to get the students' opinion about lecture videos and flipped class approach. In addition, another survey will be done with all introductory physics students (calculus and algebra based) to collect data about their textbook use, pre-reading before the

lecture, and the use of other resources they use to learn during the semester. The research will result both qualitative and quantitative assessments of the impact of lecture videos, flipped classroom approach, and students view about the reading the textbook before the lecture.

Improving Learning Experiences in Physical Science of Elementary Education Majors through Collaboration between Faculty in the Colleges of Education and Arts and Sciences

Investigators: Rachel Fiore, Early Childhood Education, John Wilson and Ben McGimsey, Department of Physics and Astronomy

Integrated Science 2002 is a required Physical Science course for elementary education majors. The course has a large enrollment and is taught as an active learning class in various lecture hall style rooms. The goal of this project is to draw upon expertise from faculty in the College of Education and the College of Arts and Sciences to 1) increase science content knowledge of elementary education students by adding hands-on instruction in physics and chemistry, 2) prepare students for the more rigorous GACE 2 exam in science and 3) assess whether hands-on instruction is viewed as a positive addition to a lecture class. Results will be analyzed through pre- and post- content tests as well as attitude surveys. Dissemination and sustainability of the program will be maintained by inviting other faculty into the collaboration, purchasing re-usable instructional materials to be shared, and creating an instructional manual for the activities to be used by future instructors and to be shared with social networking groups (e.g. STEM on LinkedIn) by June, 2014. The results will be shared with faculty in both Colleges through co-presentations at a department faculty meeting from each college by December, 2014.

Using WeBWork as the Online Platform to Supplement the Instruction of Calculus Courses

Investigators: Mark Grinshpon and Rebecca Rizzo, Mathematics & Statistics; Iman Chahine, Middle-Secondary Education & Instructional Technology

This proposal requests funds for a project devoted to examining the feasibility of utilizing WebWork – an open-source online homework system – as the online platform to be used in instruction of Calculus courses at GSU, and its efficacy in enhancing student learning in our Calculus courses, especially in comparison with other methods and platforms available for delivery of homework assignments and assessment of student learning. After an initial preparation phase, we plan to launch a pilot section utilizing the WeBWork in Calculus I and/or II courses in the Summer 2013 semester. From the pilot implementation, both qualitative and quantitative data will be collected and analyzed to measure the effects of using WebWork on students' grades, as well as their perception of this system. The homework sets created for the pilot will be available for use in future semesters to instructors both at GSU and in other schools.

Summer Research Experiences for Economically Disadvantaged High School Students

Investigator: Suri Iyer, Chemistry

We request funds to support the American Chemical Society (ACS) Project SEED program at GSU. We are expected to raise 50% of the funds, with the rest being provided by ACS. We will place economically disadvantaged high school students from the metropolitan Atlanta area in research laboratories in the Chemistry Department. Students will receive a stipend for a 8-10 week program over the summer. This program is an unique opportunity for students in their junior/ senior year in high school to learn the scientific process while contributing to ongoing projects in the research laboratories. Students work under the guidance of a professor-mentor on a daily basis on relevant research projects in the Chemical Sciences. Students will also interact with undergraduate and graduate students. They will be expected to work like a professional, typically a forty hour week for ten weeks, leading to a sense of responsibility and discipline. They will be exposed to a variety of professional development topics e.g. oral presentation skills, resume writing and interviewing skills. They will be required to write a final report and present their work in the form of a short talk and present a poster with REU students.

“3+8” Model of Undergraduate Research

Investigators: Suazette Mooring and A.L. Baumstark, Chemistry, GSU and Pamela Leggett-Robinson and Margaret Major, Chemistry and Biology, GPC

The 2013 “3+8” program will expound on the previous year’s program by offering more GPC students an opportunity to engage in an innovative undergraduate research model. The “3+8” program combine a 3 week (May 9th-28th) research experience program at GPC with an 8 week research program (June 3rd – July 26th) at GSU in Biology, Chemistry, and Physics in one Summer. This experience provides a foundation that allows GPC students to successfully make the transition to STEM programs at the 4-year institution. In addition, these students will feel more comfortable in joining the larger research groups that provide supportive environment for increased retention, progression and ultimately graduation of STEM major. From the inaugural 2012 3+8 Program, two students transferred from GPC to GSU upon completion of the 2012 3+8 program (Fall 2012) and one student was accepted into a Georgia Tech 2013 Chemistry REU. The two students that transferred to GSU are still actively engaged in undergraduate research (Dr. Barbara Baumstark’s Bio Bus and Dr. Giovanni Gadda’s group). The expectation is for more GPC students to transfer to GSU (STEM) upon completion of the 3+8 program and/or be accepted in highly competitive REU programs. Furthermore, STEM students with undergraduate research experience are more likely to attend graduate school and provide the next generation of STEM professionals.

Development of Spatial Skills and Creativity: A Collaborative Project with Art, Science and Education

Investigators: Lisa Martin-Hansen (MSIT), Brett Criswell (MSIT), Melody Milbrandt (Art), Brian Thoms (Physics and Astronomy), Chris Atchison (Geoscience), and Kyle Frantz (Neuroscience).

This mini-grant would support the work to create a Perspectives course at GSU focusing upon the development of college students' spatial skills and creative reasoning in order to increase retention, progression, and graduation of students (specifically women and possibly also have positive impact on students from underrepresented groups -- ethnic/racial minorities). Summer work will involve correspondence with science and art faculty to plan the learning outcomes and major activities within the course as well as working through logistical planning issues, identifying the instructor(s) for Spring 2014, fine-tuning the research design, and submitting a proposal to IRB for approval. Short-term analysis will be done during the course by examining the pre and post assessments of the Purdue Spatial Abilities Test: Rotations (PSVT:R). Longitudinally, we will follow the progress of the science majors who participate compared to those who do not participate keeping track of graduation rates and GPA. Our work may be disseminated in the appropriate venues related to the sciences, science education, and art.

Development of Modules for Organic Chemistry using iPad Apps

Investigators: Suazette Mooring, Chemistry

The PI has recently acquired 20 iPads using funds from the Center for Instructional Innovation Tech Fee Proposal. The funding is available to buy the iPads, a security system for the iPads and for paid apps that we will download on to the iPads. The intent is to develop and beta test modules in which the iPad is used primarily for visualization of molecules, drawing structure and 3D visualization of organic molecules and creating concept maps on the material. We will assess the number and quality of modules, and student feedback on various modules. This work will be presented at national, regional and local science education conferences.

Implementation and Assessment of Peer-Led Team Learning in Organic Chemistry at Georgia State University: Part 2

Investigator: Suazette Mooring, Chemistry

In Spring 2013, we implemented a pilot Peer-Led Team Learning format for CHEM 2401 (Organic Chemistry Problems I). As part of the pilot implementation, four organic chemistry peer leaders participated in a weekly training course and facilitated 2 sessions of CHEM 2401. Due to the encouraging results from last semester we plan to implement PLTL on a larger scale in the Fall Semester 2013. As with the Spring 2013 pilot, we will determine the effectiveness of the program by assess students' outcomes on course exams, students' overall satisfaction with PLTL and DFW rates in PLTL as compared to non-PLTL students. Additionally, we will compare student outcomes from Fall 2012 (before PLTL format) to Fall 2013 (with PLTL format). We will also continue to interview peer leaders and observe PLTL sessions. The results and findings on this study will be presented at the USG STEM conference and at Chemistry Education Conferences.

Development of Microbiology 3880 Course Modules

Investigators: Jessica M. Parilla and Robert Maxwell, Biology

This project seeks to design a packet of modules, assignments, or projects that can be used across the different sections of Microbiology 3880. The content will be written in conjunction with research microbiologists at Georgia State University and will be guided by the American Society of Microbiology's Curriculum Guidelines for Undergraduate Microbiology. The success of this strategy will be analyzed by identical entrance and exit questionnaires/exams given to students in all sections of the class.

The Use of Digital Storytelling to Enhance Scientific Literacy in the Biology Laboratory Classroom Setting

Investigators: Maggie D. Renken, Educational Psychology and Special Education, Rebekah Chapman, Biology

The use of assessment methods is an important topic widely discussed in education. At the college level exams are the primary mode of student assessment, but these tools may not assess student understanding at a high cognitive level (e.g., abstract thinking and scientific reasoning). Instructors can influence student learning by implementing alternative assessment methods—both at a summative and formative level. We propose Digital Storytelling as a method to assess biology undergraduates' understanding. Digital Storytelling involves the use of photo narratives on a digital platform. The contributions of the proposed work are twofold: (1) the development of an alternative assessment instrument, Digital Storytelling and (2) an evaluation of students' scientific literacy. Today knowledge is pervasively transmitted via multi-media platforms and story formats. Additionally, humans are predisposed to tell and to learn from stories. Yet the literature on Digital Storytelling in higher education is limited, and research on the use of Digital Storytelling in the biology classroom is almost non-existent. The proposed project will explore the potential of Digital Storytelling to encourage students to think deeply about biology content. Furthermore, the work proposed delves into and attempts to collect data focusing on the national STEM initiative, Educate to Innovate (Burke et al., 2011). If Digital Storytelling is to become an accepted instructional and assessment innovation, it is imperative to collect meaningful data regarding its impact on student learning. The proposed work also is expected to inform faculty practices and teaching strategies at GSU COE and the Biology department with regard to technology integration through Digital Storytelling.

Developing Field Activities using Place-Based Learning in an Integrated Science Course for Future Elementary Teachers

Investigators: Christy C. Visaggi, Geosciences, and Marion M. Reeves, Early Childhood Education

ISCI 2001 is an overview course taught in Geosciences required for future elementary teachers. Major revisions to the course in the last few years include a shift in sequencing of topics,

change from traditional lecture/lab to a constructivist, activity-based model, and a new collaborative approach with Early Childhood Education. The investigators on this proposal continue to refine and enhance instruction of course material upon evaluation of student outcomes over four semesters. ISCI 2001 focuses on life/earth processes, but no opportunity exists as of now for active learning beyond the classroom setting. Furthermore, data collection and interpretation by students over an extended period (common in other science courses) is not embedded in current course design despite being essential to understanding science. These deficiencies prompted us to propose development of outdoor activities providing students a mechanism for connecting to their surroundings. Place-based learning is ideal for linking concepts within an Earth system instruction framework. Qualitative and quantitative assessment of learning and pre-service teacher success will include survey feedback –and evaluation of grades and scores on certification exams. Each collaborator will disseminate results from this pedagogical work at different conferences with options including NSTA, ASTE, SASTE, GA STEM Teaching and Learning, and Geological Society of America.

A Study of Reading Strategies in Physics Students of Varying Expertise

Investigators: Joshua Von Korff, Physics and Astronomy Department, and Maggie Renken, Educational Psychology and Special Education Department

Reformed physics courses engage students in collaborative group work during class time in order to develop their physics reasoning skills. However, a less commonly known fact is that the designers of most reformed teaching methods intended that students would read the textbook before class. We believe that when students struggle to comprehend the material in the textbook, reformed teaching methods may founder in spite of instructors' best efforts. In order to pave the way for future instructional innovation that will address this challenge, we intend to examine the cognitive strategies that students use to comprehend the textbook as they read. We will also examine aspects of the text that are challenging for novice physics learners. We will compare novice and expert readers in order to place novice's reading abilities in context. Part of our analysis will be quantitative, assessing students' ability to recall the text after reading it and to answer conceptual questions about the text. Another part will be qualitative, using a grounded theory analysis (Corbin and Strauss, 2008) to categorize strategies and heuristics used by students. We will disseminate this work through publications in journals and presentations at conferences such as SREE and AAPT.

Quantification of Active Ingredients in Drugs or Nutrients by Electroanalytical Chemistry

Investigator: Gangli Wang, Chemistry

The laboratory design in Analytical Chemistry (Chemistry 4000) is antiquated. Experiments are “cookbook” and of little interest to the modern student. We propose to move this laboratory toward an analysis of over the counter pharmaceutical agents and nutritional supplements. We will first work at developing an experiment on the analysis of acetaminophen. Acetaminophen is the active ingredient of over-the-counter drug ‘Tylenol’. The electrochemical properties of

this molecule are well known. In this project, the students will gain hand-on experiences by practicing a series of analytical procedures, and learn fundamental concepts on which industrial standards of Quality Assurance/Control are routed. Briefly, the first step will be sample preparation. Solid pills will be dissolved, filtered, and diluted to proper concentrations. Basic separation procedure will be employed if necessary. Thin layer chromatography or liquid chromatography would be two feasible choices. Electroanalytical techniques (voltammetry) will be employed next to identify and quantify the specific chemical/s in the sample (acetaminophen in this case).

Workshop Physics in a SCALE-UP Classroom to Enhance a Learning by Doing Environment

Investigator: Ruili Wang, Department of Physics and Astronomy, rwang3@gsu.edu, Tel: (404)-413-6080

This project will integrate a Workshop Physics (WP) teaching format into selected sections in PHYS 1112K taught as an integrated lecture and lab in a Student-Centered Active Learning Environment in Undergraduate Physics (SCALE-UP) classroom. The WP format encourages students to learn physics completely using an experimental-based activity guide and equipment, while SCALE-UP uses short lectures, activities and guided class-wide group discussions to promote students in active and collaborative learning. The limitation of effectiveness in SCALE-UP algebra-based physics sections at GSU has shown the need for method-rich teaching and hands-on experiments. The goal of the project is to nurture students' interests toward sciences and develop their ability in self-learning by providing students with enhanced learning by doing environment. With the STEM mini-grant support a set of hands-on experimental-oriented activity guides will be developed that are a combination of textbook with real world experiments for SCALE-UP classes. The success of the project will be assessed by: 1) student outcomes on quizzes, exams, and standard CSEM test compared with previous classes; 2) evaluation on overall class performance of students from TAs and LAs; 3) a student survey about the impression of the project; 4) student overall satisfaction and development by department-wide CLASS.

Adaptive Semantic Web-based Learning Environment for the STEM fields

Investigator: Hassan A. Babaie, Geosciences

I propose to build a set of ontologies for an adaptive learning environment for the STEM fields. The system, which initially will be built to represent the knowledge and learning processes in Geology, will be extended to be adaptive to student's cognitive and physical abilities/disabilities, learning styles, and paces in any STEM field. When integrated with Web interfaces, the system will recommend pedagogic standard-compliant learning objects to instructional authors at design time, and dynamically draws the most efficient individualized learning path at runtime for students based on their profile and understanding. Applying the ontologies, the adaptive environment will allow instructors to remotely assemble learning objects into courses, assess students' progress and perception of the course material, and generate timely feedback. The system impacts students' learning by providing multiple views of the content based on learner's profile, learning path, and preferences. STEM instructors can

add incremental knowledge nuggets to the knowledge base of learning materials by using the semi-automated ontology creation tools that will be developed as part of the system. Based on the Semantic Web technologies, the system will generate personalized learning materials for students, which significantly improves students' learning experience and the effectiveness of teaching and learning STEM material.

Pedagogic Changes in Cell Biology

Investigator: Deborah J. Baro

The Cell Biology class (Biol 4800/6800) that I teach in spring and summer has a small number of students (~20) with diverse backgrounds. Roughly 20% of the students drop (i.e., 25 students initially enrolled). Currently the class is based on lectures and exams. To increase student retention I will substitute ~30% of lecture time with more engaging student-centered activities, develop/implement tools to facilitate formative assessment and develop out of class assignments. More specifically, I will: (1) Develop small group, in class learning activities. Students work in groups of 4 to solve problems in class. (2) Develop out of class learning activities whereby students do homework on the topic for the next lecture and post it online before lecture. (3) Set up on-line chat room to encourage interactions on homework. (4) Implement poll everywhere (<http://www.polleverywhere.com>) a text message-based polling system to facilitate formative assessment during class (i.e., use poll everywhere instead of clickers; it is supposedly easier and cheaper to use). (5) Develop pre- and post-test for specific lectures. Learning will be assessed as: $100(\text{post-test score} - \text{pre-test score}) / 100 - \text{pretest score}$.

Creation of New Labs for Earth Materials (GEOL 3002)

Investigator: Paulo Hidalgo, Geosciences

My plan is to update the GEOL 3002 Earth Materials Lab exercises. They have not been updated in many years and have not kept up with recent advances in the field and with what employers are requiring from our students. The new series of exercises will direct the student's attention to specific hands-on intense activities and experiments that have real world applications. During and after the activities and through a series of leading questions, students will focus on specific relationships and will rationalize these relationships according to the fundamental principles of crystal chemistry and crystallography. In this way, students will simulate and replicate the kinds of questions they would normally ask in their professional careers. For this purpose, the activities will start with questions about nature, and concentrate on the collection and use of evidence. Other questions will ask students to make connections to basic chemistry (e.g. bond types, relative strength of bond), determinative mineralogy (most likely place to develop cleavage), analytical techniques (e.g. preferred orientations for X-ray analysis), and so on. The final reflection questions will allow students to "discover" Pauling's Rules, a much more effective learning strategy than simple memorization of these rules (commonly with little or no understanding on the part of the students). I will analyze the success of these new labs by using the following techniques: Concept maps, knowledge surveys, poster presentations, portfolios (a

collection of evidence to demonstrate mastery of a given set of concepts) and exit surveys. All this information will be summarized in a written report.

Collaborative Virtual Computing Lab Environment

Investigators: Xiaolin Hu and Anu Bourgeois, Computer Science

Computing labs, where students work on assignments using specialized software and/or hardware, play an important role in computer science education (and in STEM learning in general). The proposed work is to implement a collaborative virtual computing lab (CVCL) environment and employ it for particular classes to collect data for evaluation. The CVCL builds on existing work of virtual computing labs (VCL), where students carry out computing labs on virtualized resources (such as high-end hardware and licensed software) remotely through the Internet. Currently VCL does not support student collaboration, due to the fact that students are assigned disjoint virtual spaces. It also lacks support for sharing and collaboration. The developed CVCL will allow students to reserve virtual computing labs hosting multiple participants and support remote real-time collaboration among the participants during a session. With CVCL, we will also develop several collaborative lab models, including paired remote collaboration, virtual study room, and virtual tutoring center, that support different forms of collaborations and allow flexible adoption based on an instructor's specific needs. We expect the developed CVCL will benefit a significant number of students at GSU, especially those who want to collaborate with others, but cannot physically meet up on campus due to schedule conflicts. We will apply the developed CVCL to computer science classes and collect data to evaluate it. If successful, the CVCL can be generalized to other STEM disciplines that use computing labs in learning.

New Approaches to Bridge to Higher Mathematics (Math 3000)

Investigators: Zhongshan Li, Mathematics and Statistics

Math 3000 (Bridge to Higher Mathematics) is expected to play the vital role to prepare students for more advanced, upper level undergraduate Mathematics courses. This course has had mixed success. I plan to make improvements to the design of the course so that it can help more students succeed in more advanced mathematics courses. More specifically, the following novel methods/approaches would be implemented in the new design: (1) De-emphasize formal discussion of logic. Instead, demonstrate how logic should be applied correctly in mathematical reasoning through many concrete examples worked out in detail in class. (2) Enhance the quality of examples by introducing some basic notions and results in elementary number theory and set theory. (3) Expand the discussion on countable and uncountable sets as such topics are important in subsequent courses such as Math 4661/4662 (Analysis I and Analysis II) (4) As this is a CTW course, more projects should be assigned and returned to the students promptly to get frequent feedback. (5) A brief discussion of the complex numbers should be added to this course, as the complex numbers are used in more advanced math courses. (6) Leave out some topics which properly belong to subsequent courses, such as Concepts of Algebra (to be

covered in Math 4441/4442) and Concepts of Analysis (to be covered in Math 4661/4662). It is expected that implementing these new approaches in Math 3000 will result in significant improvement of student success in upper level mathematics courses.

Biochemistry Snapshots in Organic Chemistry

Investigators: Gigi B. Ray and Joan Mutanyatta-Comar, Chemistry, Chemistry

Students often compartmentalize the material they learn in different courses; if we help them see connections between courses they are likely to better integrate the topics and apply ideas learned in one course to another, and gain an overall deeper understanding of science. As students are first introduced to various types of reactions and functionalities in organic chemistry, if they see that biological systems use similar reactions and mechanisms, they are more likely to be motivated to learn organic chemistry. The goal is to help students transition from studying reactions to applying them to complex biochemical pathways. We propose to create several short PowerPoint presentations of how topics learned in Organic I and II courses are directly applicable to important biological processes. The slides will be distributed to all faculty teaching undergraduate organic chemistry. The idea is to connect 'abstract' organic chemistry principles to biological situations familiar to students (such as digestion or vision) and medical and molecular biology topics of interest to many (how carbohydrate and fat metabolism and gene expression affect obesity). End of semester surveys will allow a means to evaluate the benefit of these snapshots in helping students see the links between their biomedical interests and what they learn in undergraduate chemistry courses such as organic and biochemistry.

Mathematics in Neuroscience

Investigator: Andrey Shilnikov, Neuroscience

This project on Mathematical Neuroscience is genuinely cross-disciplinary research bridging applied mathematics with neuroscience. It will extend and generalize our understanding of dynamical principles in neural systems. Our findings will provide a systematic basis for comprehension of plausible biophysical mechanisms for the origination and regulation of rhythmic patterns generated by neural networks. The PI has organized a series of workshops on applied mathematics and neurodynamics, which allow students and researchers from the Southeast to communicate directly to the world leading experts in the field. YouTube presentations will be created.

Integrating Active Learning and Place-Based Approaches in a Course Revision for Geosciences

Investigator: Christy C. Visaggi, Geosciences

Introductory Geosciences II at GSU deviates from other USG schools upon examination of proposed learning outcomes (see below link). Furthermore, labs and lectures are disconnected

yielding a lack of inquiry-based activities for ~400 students. The absence of active learning combined with missing contextual understanding and appreciation of local geology leaves students unprepared to explain Earth processes around them. Last summer I mentored an education student in revising four labs in order to 1) improve alignment with USG standards and 2) do so by increasing place-based and active learning through a focus on Georgia. Pre-/post- surveys examined changes in student success and attitudes. This was a first step; more work is needed. Assessment results and ongoing lab modifications led recently by Dr. Chris Atchison (no longer at GSU) serve as a starting point for future work. I seek summer salary with goals of 1) further developing labs per USG guidelines using above the approaches, 2) continuing to mentor students in redesigning additional labs and evaluating their impact by expanding on prior pre-/post- surveys, 3) presenting results regionally next spring, and 4) utilizing such activities as a basis for a Georgia Geographic Alliance NSF DK-12 proposal on STEM outreach and education.

Portable Mobile Security Lab for Enhancing Research Ability of Undergraduate Students in Multiple Courses

Investigator: Yanqing Zhang, Computer Science

We will develop a portable low-cost mobile security lab with mobile Android Tablets for multiple courses (Computational Intelligence in Fall 2015, Operating Systems and Artificial Intelligence in Spring 2015) to train undergraduate students to improve research skills by doing projects mobile security, and make great effort to produce more future cybersecurity workforce. The number of portable lab projects, the number of students using the portable lab, project design quality scores, and project report quality scores, and the satisfaction rates of students on the learning outcome will be used to assess student learning and research outcomes. Pre and post assessments are also used in the objective evaluation. We will use an anonymous questionnaire to be completed at the end of the semester along with the regular course evaluations. Strengths and weaknesses of the evaluation results will be provided for further evaluation and future improvement

Redesigning a Mathematics Content Course for Future Middle School Teachers

Investigator: Nermin Bayazit, Middle Secondary Education, College of Education

This project aims to redesign one of the few mathematics content courses for future middle level mathematics teachers enrolled in the BSE program in the Department of Middle-Secondary Education. Students who choose mathematics as one of their concentration areas are required to complete at most 6 mathematics courses. Limited experience with mathematics makes the required courses (EDMT 3350 is one of them) critically important to prepare them to teach rigorous curriculum in the classroom. With this motivation, EDMT 3350-Topics in Middle Grades Mathematics, will be restructured so that each strand (number theory, algebra, geometry, probability and statistics) will be presented through modules in Fall 2014. Each

module will include 3 carefully designed tasks (total of 15 tasks) that will foster problem solving, and mathematical communication skills, as well as enhance their pedagogical practices by requiring them to tackle with the problems from both students' and teachers' perspectives. Both qualitative (reflections, course assignments, and interview transcripts) and quantitative (pre- and post-test) data will be collected to analyze the effectiveness of these tasks. Finding from this project will be communicated locally, nationally and internationally through conferences, and a manuscript submission to Mathematics Teaching in the Middle Level.

Designing an Online Adaptive Tutoring Environment to Enhance Students' Performance in Undergraduate Mathematics

Investigators: Iman Chahine, Middle and Secondary Education, Saeid Belkassim, Computer Science, and Mark Grinshpon, Mathematics & Statistics

This project requests funds to develop a web-based tool to assess student learning in Calculus. The system generates multiple choice questions dynamically depending upon students profile and suggests particular resource locations that contain the needed knowledge. This helps the student know where he currently stands in class and allows teachers define their tests and evaluate their students with a minimum of effort. The development stage will take place during Summer 2014, and a project pilot will be conducted in Fall 2014. The project will test the effectiveness of the web-based tool in Calculus. Two types of data will be collected: quantitative and qualitative. Six instruments will be employed: online weekly quizzes, observation logs, Calculus tests, pre- and post-skills check quizzes, pre- and post-attitude questionnaires, and informal interviews. To analyze quantitative data two techniques will be employed: ANOVA and *t*-tests. Qualitative data will be analyzed by screening for emerging patterns in students' responses. The ultimate goal of the project is to use the web-based adaptive environment to help students who lack knowledge in basic calculus content overcome their weaknesses and build their confidence. A website will be designed to provide regular updates and share findings on the progress of the project.

Scaffolding Mathematics and Science Teachers Practices to Enhance Middle Level Students' Computational Thinking Skills Using Project-Based Learning

Investigator: Iman Chahine, Middle and Secondary Education

This new project requests funds to launch a 20-hour training program in Summer 2014 to support the professional development of twenty (20) middle school mathematics and science teachers from a high need LEA-Atlanta Public Schools (support letter attached). The project will focus on helping mathematics and science teachers cultivate a facility with computational thinking in middle level students by engaging in project-based scientific explorations. The training will be conducted over five days (4 hours/day= 20 hrs.), and four days of follow up training during the 2014-2015 school year (6 hours/day=24 hrs.). During training, teachers will engage in guided discussion and reflections focused on developing lesson plans to foster students' computational thinking skills in mathematics and science. Two types of data will be

collected: quantitative and qualitative. Four instruments will be employed: observation logs, pre- and post-professional development surveys, pre- and post-attitude questionnaires, and informal interviews. To analyze quantitative data two techniques will be employed: *t*-tests and structural equation modeling (SEM) to extract latent factors underlying teachers' attitudes. Qualitative data will be analyzed by screening for emerging patterns in students' responses. A website will be designed to provide regular updates and share findings on the progress of the project.

Collaborating to Re-design, Re-examine, and Integrate CCSS-M in a Secondary Mathematics Methods Course: Focus on Module of Statistics

Investigators: Pier A. Junor Clarke, Middle & Secondary Education, Nermin Bayazit, Middle & Secondary Education, Rebecca Rizzo, Mathematics & Statistics

In our initial teacher preparation (ITP) program for pre-service secondary school mathematics teachers (PSSM), we, two mathematics educators from the College of Education and mathematician from the College of Arts and Sciences will collaborate to redesign, develop and co-teach a module of statistics in the second mathematics methods course EDMT 7560 in the ITP program. We will facilitate and model the development of lesson plans for the Common Core State Standards for Mathematics (CCSS-M) focusing on the module of statistics, while embracing reasoning and sense-making skills and mathematical practices. Our goals are that PSSM teachers will be able to analyze student test score data and make appropriate interpretations of students' learning and their own teaching and (2) will gain a better understanding of the content and mathematical practice standards in statistics. One of the lessons learned from our previous research, is that we must pre-plan meticulously for effective, smooth, and well integrated co-teaching sessions to maximize the use of each instructor's capital and ensure there is fluidity for smooth transitioning among content, pedagogy, and content pedagogical knowledge.

Improving Preparation of Elementary Teachers for Science Teaching Through Collaboration Between the Faculty Teaching Integrated Science 2001 and the Faculty Teaching Integrated Science 2002

Investigators: Rachel Fiore, Early Childhood Education, Ben McGimsey, Physics and Astronomy, Marion Reeves, Early Childhood Education, Christy Visaggi, Geosciences, John Wilson, Physics and Astronomy

ISCI (Integrated Science) 2001 and ISCI 2002 are each taught through a collaboration between faculty in Arts and Sciences and faculty in the College of Education; however, there is no current collaboration between the faculty teaching ISCI 2001 and the faculty teaching ISCI 2002. The purpose of this project is to bring together the faculty from both courses in a 2-day summit to examine the 2 courses together for the purpose of recommending modifications to the courses. The success of the grant will be determined by the production of the artifacts as outlined in the

agenda and the implementation of recommended modifications to ISCI 2001 and ISCI 2002 in Fall 2014.

A Physics-Based Model for Biomechanics Laboratory Education

Investigators: Mark Geil, Kinesiology & Health, Jianhua Wu, Kinesiology & Health, Brian Thoms, Physics & Astronomy

KH3600 Biomechanics serves almost 200 undergraduate students annually. The course integrates physics, anatomy, physiology, mathematics, and mechanical engineering to teach kinematics and kinetics of human motion. Each offering includes as many as four laboratory sections meeting once a week for 1.5 hours. Our student feedback regarding the labs is generally negative. Many concepts presented in lecture are not part of the lab curriculum, even though they lend themselves well to practical application. When the Biomechanics Laboratory participated in a 2009 STEM grant for a Summer Physics camp for high school students, we realized the potential for integration between some aspects of physics laboratories and our course content. Physics has a much longer history in applied education than biomechanics. Crawford's foundational article on the subject dates back to 1954, before biomechanics was fully recognized as a discipline. In this project, we will revitalize our KH3600 laboratory using the rich history in physics. We will infuse more practical application, taking existing physics labs and applying them to human function. The potential exists to augment existing physics labs as well. We will assess impact through a custom survey administered prior to (Fall 2014) and after (Spring 2015) implementation of the new laboratory

Everyday Everywhere Math: Using Learning Trajectories & Literacy Integration Approach in the Early Childhood Classroom

Investigator: Kyong-Ah Kwon, Early Childhood Education

Early math skills are a vital foundation for later math and literacy outcomes (e.g., Cross et al., 2009). In a call to improve math outcomes, two leading professional organizations in early childhood education and math education urged that young children should experience effective and research-based curriculum and practices (NAEYC/NCTM, 2002). However, most of teachers for young children are poorly prepared to teach math and do not know/feel comfortable teaching math (Copley, 2004). The Birth through Five (B-5) program in Early Childhood Education currently offers only minimum instruction for math education. Thus, to supplement and strengthen the math portion of the existing method class in the B-5 program, I am planning to collect data from children and teachers, develop a module for an early childhood math program, and implement the pilot program with pre-service teachers. I am going to develop the program based on the learning trajectories approach used in an evidence-based early childhood math curricular, Building Blocks. It will help teachers assess the current levels of children's math knowledge and skills, develop goals and teaching strategies, and incorporate math into daily activities. I will also use a series of problem-solving stories and develop hands-on materials as an effective medium for teaching early childhood math.

Using Technology to Promote the Mathematics Content Knowledge of Elementary Teachers

Investigator: Shonda Lemons-Smith, Early Childhood Education

In order to provide cognitively demanding, high quality mathematics instruction to learners, teachers must possess strong content knowledge. Generally, secondary mathematics teachers enter the profession with stronger mathematical preparation than elementary teachers. In recent years there has been a call for increasing the mathematical content knowledge of elementary teachers (e.g. Ball 2002, 2003; Ball & Bass, 2000; Hill & Ball, 2006).

The major goal of this project is to identify gaps in GSU pre-service elementary teachers' mathematical content knowledge and strengthen those areas. Students enrolled in the summer course, Foundations of Teaching and Learning Mathematics, will be participants in the project. Students will engage in mathematical tasks and modules across various content strands with emphasis on number and operations and problem solving. In a typical course, students use a traditional math text and solve problems using paper and paper. In the proposed project instruction would be expanded to include digital content to deepen students' math conceptual knowledge and understanding. The project will transform the mode of mathematical learning by using iPad mini technology and creating a math classroom learning lab. The Apple App Store features over 65,000 education apps so the range of learning possibilities is extensive. The course will utilize various apps including iTunes U, Khan Academy, Math Ref, Math Solver, MyScript calculator, and White Board. In addition to providing students with digital content, the iPad mini also offers students the opportunity to develop content and express their mathematical thinking through audio and video files. Students can also engage in mathematical dialogue with other students and the course instructor via Facetime. The classroom learning lab provides an innovative format to promote mathematics learning and is sustainable in future semesters. Each semester the course instructor will check out iPad minis to students enrolled in the course to use for the semester. The math classroom learning lab has the potential to impact approximately twenty five GSU students each semester. Those students' increased mathematical knowledge will in turn positively impact the K-5 students they encounter in their student teaching experience and ultimately their full-time teaching position after graduation.

Using Text to Engage Children in the Language of Scientists

Investigators: Laura May, Early Childhood Education, Gary Bingham, Early Childhood Education, Thomas Crisp, Early Childhood Education

In an attempt to increase students' college and career readiness, the Common Core State Standards increased the percentage of informational texts in K-12 classrooms of participating US states. Yet, elementary teachers are implementing the standards in ways that comply but fail to address the original goal of college and career readiness. One obstacle is that informational texts are defined so broadly that narrative texts (e.g., biographies, picture book stories about science) meet criteria and predominate because teachers see them as a way to

make “unfun” science more engaging. This approach is problematic because 1) children are already interested in science, and 2) stories do little to contribute to conceptual growth and are often factually inaccurate. Expository texts that allow children to participate in and acquire the language of scientists are often discounted, or, as in the case with textbooks, only used instructionally in the ineffective ways that have contributed to thinking of science as uninteresting in the first place. This proposal seeks funds to increase the STEM preparation of an elementary teacher preparation program focused on urban schools. The project will enrich the program’s initial literacy methods course through the incorporation of recently published children’s picture books designated as outstanding by the National Science Teachers Association and books related to STEM from the National Council of Teachers of English Outstanding Nonfiction Orbis Pictus Award List. As a part of the course, teacher candidates will learn 1) more nuanced systems for classifying informational texts and 2) instructional strategies to engage children with expository texts. A tutoring program linked to the course also allows for hands-on practice implementing these strategies with children.

Achieving an Upper Bound: A Study of Undergraduates’ Understanding of Sources of Science Knowledge

Investigator: Maggie Renken, Educational Psychology and Special Education

Prior USG STEM Initiative research employed a web-based tool to explore grade 2-8 students’ abilities identifying and evaluating sources of knowledge (SoK) in scientific explanations. Findings indicate differential individual abilities in identifying SoK and developing appreciation for scientific process in science explanations among middle school students. In light of differential ability and developmental trends, important empirical questions remain. As a next step, it is necessary to establish an upper bound of the current learning trajectory. As such, I aim to consider the SoK understanding of undergraduates enrolled in STEM coursework. Students ($n = 75$) enrolled in Biology 1103/1104 during Summer 2014 will complete the web-based SoK tool. Performance on forced-choice items will be analyzed using an IRTree modeling approach for trends in missing responses and identification abilities. Open-ended evaluations will be analyzed using a mixed-methods approach. Cluster analysis will consider differences in undergraduates’ and elementary and middle school students’ performance. Beyond dissemination in typical venues, findings will be shared with Biology instructors. Results are important for understanding how undergraduates in Biology labs think about the sources of information they are taught in class. The PI will work closely with interested instructors to best realize potential pedagogical implications.