**GK-12 "Fellows in the Middle"**

**Goals and Objectives.** This project matches four science and four math graduate students at Montclair State University (MSU) each year with eight middle grades science and math teachers. Over the five-year grant period, a total of 16 pairs of science-math Fellows are placed in five contiguous urban/suburban districts in northern New Jersey (NJ). Project activities include recruitment and training of Fellows and teachers; development, delivery, integration and district adoption of interdisciplinary science and math units; and evaluation of the project’s impact on all participants. Fellows are trained in inquiry-based interdisciplinary teaching practices consistent with state and national standards. As a team, science and math Fellows, their cooperating teachers, and MSU Research Advisors (RA’s) design interdisciplinary units based on scientific processes and field experiences, and prepare students for an annual Science/Math Day. Evaluation activities guide the project and assess its efficacy.

**GOAL 1: Equip Fellows with skills necessary to excel in STEM careers.**

**Objective:** Improve Fellows’ team and communication skills, and career opportunities.
- Fellows communicate the importance of scientific processes to middle grades students.
- Fellows present research results in an accessible way to students at Science/Math Day.
- Fellows work in teams to develop and teach interdisciplinary lessons and units.
- Fellows present units to other Fellows, RA’s, project personnel, and district representatives.
- Fellows broaden career opportunities through interactions with grant-related personnel.

**Objective:** Develop Fellows’ understanding of middle grades science and math education.
- The Summer Institute for Fellows focuses on inquiry-based approaches using materials from NSF-supported Connected Mathematics Project (CMP) and Full Option Science Systems (FOSS), and Science and Technology for Children (STC).
- Monthly Professional Development Workshops connect the National Council of Teachers of Mathematics (NCTM) Standards, National Science Education Standards (NSES) and NJ Core Curriculum Content Standards (NJCCCS) to the classroom.
- Experienced teachers, with the RA’s and project staff, provide “on-the-job” training.

**GOAL 2: Enable teachers to inspire students in science and math.**

**Objective:** Strengthen teachers’ knowledge of science and math content and research.
- Monthly workshops focus on science and math content and the scientific process.
- Fellows share their content and research expertise with teachers.
- RA’s visit schools monthly and provide guidance on content and ways to connect middle school curricula with cutting-edge science and math research.

**Objective:** Familiarize teachers with innovative approaches to teaching science and math.
- Teachers attend Summer FOSS/STC/CMP workshops.
- Monthly workshops emphasize technology, interdisciplinary pedagogy, inquiry-based lessons, cooperative learning, and inclusion instruction for students with Limited English Proficiency (LEP) or Specific Learning Disabilities (SLD).
- Fellows share information about innovative teaching methodologies from the Summer Institute, work with RA’s, and graduate coursework.
- International experiences connect to middle grades curricula and teaching practices.
GOAL 3: Increase middle grades students’ interest and achievement in science and math.

Objective: Strengthen interdisciplinary connections in science and math classrooms.
- Students, Fellows, and teachers engage in field experiences at appropriate sites, based on an annual interdisciplinary theme. These themes also motivate interdisciplinary units.
- The units, inspired by inquiry-based pedagogies and connected to cutting-edge research, become an integral component of the districts’ permanent curricula.
- Classes prepare for, compete in, and judge projects at an annual Science/Math Day.
- Science-math Fellows, teachers, and RA’s meet regularly to plan and refine lessons.

Objective: Improve science and math achievement of underrepresented minority groups, in particular Hispanic and recent immigrants, as well as students with LEP or SLD.
- Fellows and RA’s are recruited to reflect the diversity in the schools.
- LEP and SLD experts lead Summer Institute sessions and monthly workshops.
- LEP and SLD experts review curriculum units for their use in inclusion classes.

Objective: Expose students to cutting-edge research, scientific methods, and the benefits of pursuing science and math in post-secondary education and as a career option.
- Fellows and teachers implement experiments and projects that promote the scientific process. They use current technology and dynamic software, making connections to cutting-edge research in ways that are appropriate for middle grades students.
- Fellows are role models for the middle grades students.
- College of Science and Mathematics (CSAM) faculty, Fellows, industry and minority group representatives, and international scholars present their research and industry-related issues during Science/Math Day. They discuss examples of cutting-edge research that are extensions of middle grades science and math.
- CSAM students conduct campus tours for middle grades students during Science/Math Day.
- Students converse about research methodologies through interactive videoconferences with scientists in the rainforests of Panama and other habitats.
- Selected Fellows and teachers collaborate with international researchers and educators. These collaborations put middle grades math and science instruction in a global context.
- Students correspond and exchange ideas with students in other countries. They conduct comparative studies such as those modeled after the Noon Day Project.

GOAL 4: Institutionalize project activities at MSU.

Objective: Enhance STEM graduate programs by promoting communication and teamwork.
- Nominated and selected CSAM students present research results at Science/Math Day.
- Graduate students gain exposure to field experiences and interdisciplinary work.

Objective: Strengthen University’s partnerships with local school districts and industry.
- Use project evaluation results to guide the institutionalization of the project.
- Work with MSU’s Development Office and the CSAM Advisory Board to obtain support from local industry to continue the project.

Objective: Develop post-baccalaureate science programs for middle grades teachers.
- Deepen MSU faculty’s awareness of education issues and commitment to K-12 education.
- Develop and institutionalize an interdisciplinary course modeled after this project.
Brief Project Plan

MSU’s expertise and success with in-service science and math teacher training

CSAM faculty members maintain close connections with the public schools. During 1993–1997, members of the math faculty worked with 85 middle grades teachers from Newark, NJ’s largest district. Selected teachers continued with a sequence of five content courses based on the NCTM content standards. Concurrently, MSU was the primary provider of professional development on the use of hand-held technology to enhance the teaching of science and math in NJ.

MSU’s Professional Resources in Science and Mathematics (PRISM), a regional NJ Statewide Systemic Initiative center affiliated with the National Science Resources Center, is housed in the Bristol-Myers Squibb Center for Science Teaching and Learning. It sponsors professional development activities that enrich school science and math instruction using research-based pedagogies. Through PRISM’s Adopt-A-Prof program, middle grades science and math classes “adopt” a professor for the school year. Faculty members visit their school monthly and work with teachers to deliver lessons. The PRISM Rainforest Connection videoconference engages students with scientists in Panama and other locations. CSAM hosts a variety of campus events for teachers and students. Every year several hundred middle and high school students compete in the Northern NJ Science Olympiad and attend Math Day where faculty members make student-friendly presentations on thought-provoking topics.

Description of Local School Districts

The participating school districts—Kearny, North Arlington, Lyndhurst, Rutherford and East Rutherford—are located in NJ’s industrial corridor that runs northward from Newark. This area is becoming increasingly urban and experiencing an influx of immigrants from Latin America, Eastern Europe and Asia. Immigrant children create a diverse and changing student population resulting in new demands and challenges. Kearny, the largest of the five districts, is an urban-enterprise zone. English is a second language for 70% of the students in the district. At the middle grades, 45% of the students are Hispanic. Franklin, a Title 1 school, is expected to participate. In the last year for which data are available, Kearny students with LEP and SLD had math proficiency rates lower than that mandated by the state. Economically disadvantaged students in the district had a math proficiency rate markedly lower than others in the district.

Similarly, North Arlington has a large number of students with SLD (20%) and LEP. Math scores for all students lag far behind language arts literary scores on NJ’s Grade Eight Proficiency Assessment. The North Arlington Middle School is a Title 1 school. In Lyndhurst, the collaborating schools are expected to be Roosevelt and Washington, both of which receive Title 1 funding. The district is continually seeking to improve the achievement of all students in science and math and to strengthen the content knowledge of its science and math teachers. In Rutherford, both the Pierrepont and Union schools will participate. One of that district’s goals is to increase math achievement for all NCLB subgroups including special education and Hispanic students. In East Rutherford, 65% of the middle grades students belong to a minority group, with 36% identified as Hispanic. Twenty-seven percent of the middle grades students have disabilities that affect their schooling. The Faust School, East Rutherford’s middle school, is a Title 1 school.

The challenges of narrowing the achievement gap among the NCLB subgroups and enhancing the knowledge of the middle grades science and math teachers demonstrate the need for the Fellows in the Middle project in these districts. In all five districts, only a few middle
grades science and math teachers hold degrees in their subject area. Participating in the Professional Development Workshops and working with Fellows and RA’s will strengthen the content knowledge of the teachers. Significant state and federal funds go to large urban northern NJ districts such as Newark and Paterson. As a result, smaller districts in the same geographical region have often been overlooked. This project is a timely opportunity to enhance STEM instruction in the five participating districts.

**Annual Interdisciplinary Theme**

Each year, an interdisciplinary theme based on state and national science and math standards is identified. These annual themes guide training activities, the selection of field experiences and the development of curriculum units. The annual themes are expected to be Earth History, Planetary Science, Populations and Ecosystems, and Chemical Interactions. These broadly defined themes provide latitude for all Fellows and teachers to develop lessons with interdisciplinary connections.

**Description of Middle Grades Activities**

**Fellows in the Classroom:** Fellows are in classrooms for two full days each week, gaining full exposure to day-to-day activities. They are still able to attend courses, colloquia and seminars and conduct research at MSU. The usual middle grades teaching load is five classes. In all but one district, teachers are assigned one grade level. In Lyndhurst, a few math teachers are assigned multiple sections of grades 7 and 8. Fellows matched with those teachers would support instruction for both grades. Fellows observe classes for the first three weeks of the school year, becoming familiar with the school infrastructure, students, teaching style of their cooperating teacher, curriculum, and administration. Fellows and PI’s convene weekly in September so that Fellows have ample opportunity to clarify their understanding of classroom mechanisms before participating more actively.

Starting in October, Fellows and teachers team-teach lessons. The Fellow’s role is to infuse the curriculum with science and math content. Fellows also introduce innovations such as new technologies or laboratory techniques, promote scientific processes, and share the results of recent research. Fellows seek and make connections between their research and content expertise and the middle grades curriculum. Weekly meetings, Professional Development Workshops, and monthly meetings with RA’s provide opportunities to discuss such connections.

**Curriculum Units:** In each of four years, two interdisciplinary curriculum units are developed, addressing specific NJCCCS science and math standards. The annual theme guides the development of the units implemented in the weeks surrounding the fall and spring field experiences. Sites such as the NJ School of Conservation, Sterling Hill Mining Museum, Dreyfuss Planetarium, Essex County Environmental Center, NJ Marine Sciences Consortium, Great Swamp National Wildlife Refuge, Liberty Science Center, and the Intrepid Sea-Air-Space Museum have been identified. Each site has resources to train Fellows and the project team. The units are aligned with Project 2061 to emphasize and connect big ideas and address age-appropriate concepts and process skills in an inquiry-guided way. As an example, an interdisciplinary unit for the Sterling Hill Mining Museum would include math explorations on crystals as polyhedra, and science investigations on liquid crystals and the formation of minerals in the earth’s crust.
At the end of each semester, Fellows present their curriculum units from that semester to project personnel and representatives from all five school districts. From the presentations, district representatives understand how part or all of the units can be integrated into their middle grades science and math curricula. Although the interdisciplinary units are designed for use with specific sites, they can be adapted to other locations. A unit for the Great Swamp National Refuge might involve students estimating the number of different plant species in the refuge by analyzing the species found in a small area. Students would use middle grades science and math skills that connect to cutting-edge research—for example, to the work being conducted in a Panamanian rainforest as recently reported in the New York Times (Jackson, 2006). This student investigation could be conducted in other parks. This flexibility increases the functionality of the units and provides an assurance that grant activities are sustained beyond the funding period.

**Science/Math Day:** Each spring, students, teachers, and Fellows participate in Science/Math Day at MSU. Students rotate among three sessions: seminars, poster contest, and campus tours.

Students attend 30-minute seminars, presented by Fellows and other graduate students, RA’s, representatives from STEM industry and minority-serving professional organizations, and international scholars. The seminars present topics that are both interesting and accessible to middle grades students. CSAM faculty share their expertise on cutting-edge research topics such as mathematical modeling of black holes, DNA sequencing, animal behavior, virology, liquid crystals, applied dynamical systems, geological history of NJ, applied game theory, nutritional biochemistry, meteorite properties, remote sensing, and volcanic processes in the Andes. The goal of the seminars is to show students that cutting-edge research is an extension of their current studies and to promote science and math as worthwhile pursuits.

Student posters are displayed in the Student Center Ballroom. The posters are the culminating project for the middle grades students. In the months preceding the Science/Math Day, classes have worked with Fellows, teachers, and RA’s to design and conduct experiments and create their posters. At the poster session, students view the posters and identify the top five from outside their district. Results are tabulated and the ten winning class posters are announced at the end of the day. Photographs showcasing the posters and students are displayed in the schools, the MSU library, and on the project website.

The third activity is a campus tour led by CSAM students. Special attention is given to science and computer laboratories and other research and educational facilities. Students learn about the day-to-day activities of college students in general, and more specifically, of science and math students. By exposing the students to STEM opportunities, we are encouraging them to consider pursuing science and math in college and beyond.

**Rainforest Videoconference:** As part of PRISM’s outreach, Dr. Jacalyn Willis leads a team of researchers that hold interactive videoconferences from the rainforests of Panama. She has agreed to annually conduct live videoconferences from the rainforest with each of this project’s participating middle schools. Additional field sites for hosting videoconferences are being developed in a cloud forest in Panama, coral reef in Belize, and on a Georgia barrier island. The videoconferences are set within suggested curriculum contexts so that students are prepared in the subject matter and can ask pertinent questions. Professional development for teachers via videoconference is offered to deepen content understandings and suggest field and classroom activities that relate to the videoconference topics. Topics of discussion with scientists cut across habitats with themes such as food webs, energy transfer, biodiversity, and adaptations.

**International Components:** The project has three international components: Fellow- and teacher-visits to international institutions, visits by international scholars to MSU, and middle school research collaborations.
MSU has ties with institutions that include the Darwin Institute at the Galapagos Islands, Smithsonian Tropical Research Institute in Panama, East China Normal University, Shanghai Normal University, Wonkwang University in Korea and Burapha University in Thailand. We expect that at least four Fellows and four teachers will be selected to visit these international sites for two summer weeks and to collaborate on research and educational projects with international colleagues. For example, at the Smithsonian Institute in Panama, Fellows and teachers would learn about data collection and analysis in long-term wildlife ecology studies that integrate findings on food supplies and population variations. The specific sites and projects are chosen based on the connections between the Fellows’ research interests and ongoing projects of international collaborators. As part of their visit, teachers and Fellows have opportunities to visit local schools and interact with teachers.

A formal application process, that includes an essay, letter of recommendation from a colleague, and interview by the PI’s are used to select Fellow and teacher participants for this component of the project. RA’s, whose expertise most closely matches the objectives of a site visit, work with Fellows and teachers in the month preceding their departure to advise them about various aspects of the research project. Given the short duration of the team’s visit, ongoing post-visit communications with the host institution are required. The research experiences of the teams are shared with all Fellows and teachers at a Professional Development Workshop in the fall. The group generates ideas for the meaningful integration of the international experience into the curriculum units. MSU’s Global Education Center is a partner in the international component and has agreed to fund part of the Fellows’ travel expenses. School districts have agreed to assist PI’s with identifying potential funding sources for their teachers. The Center employs a staff of nine full-time professionals and two full-time administrative assistants who will make all logistical arrangements and introduce Fellows and teachers to cultural and language considerations.

The Global Education Center regularly hosts international scholars at MSU through the Distinguished International Scholars, Forum on International Issues, and Visiting Scholars programs. Each year, participating science or math researchers will be invited to speak at the Science/Math Day about contemporary scientific issues in their countries.

The third component involves pairing selected middle grades classes with classes abroad. Project personnel, such as Drs. Li and Willis, and the Global Education Center have contacts with middle grades teachers in other countries and will assist project directors with matching classes. For example, Dr. Li is in contact with the principal of Beijing San Fan Middle School, a school recognized for its success in science competitions. Together, through communications via teleconferencing and e-mail, each pair of middle grades classes designs and executes a comparative experiment that investigates topics such as air-quality, nutrition, and measuring the size of the earth. Matched teachers share experiences and ideas about middle grades education.

The international components of this project broaden participants’ understanding of scientific research, expose them to different cultures, and introduce them to a network of international students, researchers, and educators. Students learn about scientific research in global contexts, and Fellows and teachers have opportunities for extended research and educational work with international colleagues. It is expected that Fellows will become interested in pursuing further international collaborations in their studies and careers.

Benefits

Fellows: Through their work with teachers, colleagues, RA’s and middle grades students, Fellows strengthen their communication skills and become more adept at teamwork. They
experience the challenges and rewards of contributing to science and math education, thereby becoming advocates of public schools, wherever they are employed. Working with others on the interdisciplinary units contributes to their understanding of scientific research by exposing them to connections among various scientific disciplines. The project introduces them to RA’s and STEM professionals who increase their awareness of career options. Their teaching experiences and presentations to colleagues and project staff deepen their understanding of science and math and their own research. The experience of delivering scientific presentations for the general audience prepares them to make formal and informal presentations in industry or academia.

**Teachers:** Through Professional Development Workshops and interactions with Fellows and RA’s, teachers update and increase their knowledge of science, math, technology, scientific methods, and inquiry-based interdisciplinary pedagogy. They learn much of this material in an active hands-on manner, and thus are able to use those constructivist approaches in their own teaching. All districts accept up to 75 continuing education units per year for participating teachers. Rutherford has agreed that the experience meets the district’s expectation for teachers to complete one 3-credit course every three years. Kearny will allow teachers to use project work and experiences for salary guide advancement. A part of each teacher’s stipend is reserved for travel to conferences to encourage them to become professionally active.

**Schools and Middle Grades Students:** Schools benefit from having pairs of science and math teachers who have updated and broadened their knowledge of the subject and have been trained on preparing and delivering hands-on, inquiry-based lessons. Students benefit by receiving enhanced instruction from Fellows—who are models of young scientists—and by participating in the project’s international components. Minority students become aware that incorrectly perceived socio-economic and cultural barriers to their participation in science and math can be surmounted. Schools benefit from the Fellows’ knowledge of content, understanding of research methodologies, awareness of current STEM findings, and experience with using new technologies and laboratory equipment. Other science and math teachers are able to access project-related lessons, activities, and units through the project website. The interdisciplinary units become a permanent component of the middle grades curricula and serve as models of innovative instruction for other schools around the country.

**Research Advisors:** The RA’s benefit from working with outstanding graduate students attracted to CSAM through this program. They also develop a better understanding of the school science and math curricula that prepared many of their undergraduate students and learn how to identify best practices in local schools. Through their contacts with the school districts they are able to recruit students to CSAM programs.

**University:** MSU benefits by strengthening its collaboration with area schools and increasing its visibility as an institution with strong programs in science and math. It attracts outstanding STEM graduate students with increased numbers from underrepresented minority groups and increases faculty research, collaboration and external funding opportunities. This cultural change attracts corporate donors interested in supporting science and math education in public schools. Faculty members understand middle grades science and math curricula and develop strong graduate certificate and degree programs in science education that increase graduate enrollments. A graduate-level course, Connecting Mathematics and Science, based on the Summer Institute and the Professional Development Workshops, is developed as a permanent CSAM offering. Graduate students improve their communications skills by presenting their research at the annual Science/Math Day, which also contributes to undergraduate recruitment.
Recruitment and Selection

**Fellows:** Fellows are recruited from STEM students at other institutions and upper division undergraduate and current graduate STEM students at MSU. Recruitment and selection activities occur in the spring semester. At MSU, brochures describing the project are posted in CSAM, especially in the Health Careers office—the minority recruitment and retention program that has made CSAM among the most diverse colleges at MSU. The project is announced in all graduate and upper-level undergraduate STEM courses. Application information appears in the university paper and is announced on its radio station. Notices of the program are sent to all four-year institutions within a 200 km radius of MSU and included with CSAM graduate admissions application packets. Announcements are sent to appropriate job fairs, conferences, and professional organizations. Applications are available in the offices, newsletters, and websites of The Graduate School, Admissions Office, CSAM, and STEM departments.

All candidates applying to the MSU Graduate School in a STEM discipline prepare a statement of objectives essay and submit GRE scores, transcripts for all undergraduate and graduate work, and two letters of reference. Candidates applying to be a Fellow prepare an additional essay addressing the teaching of middle grades science and math, and submit a total of three letters of reference; including one from a professor that addresses the candidate’s capacity to conduct research and another from a job supervisor. Candidates must have a science or math major with a 3.5 GPA and either have been accepted or be concurrently applying to a CSAM graduate program. To strengthen interdisciplinary work in the schools, preference is given to applicants with at least 12 credits in a STEM discipline other than their major.

The recruitment team ranks all applications and interviews the top candidates. During the interview, applicants are asked about their career goals, work with children and anticipated benefits from the program. Ideal candidates understand issues of diversity, have a stated or demonstrated interest in working with middle grades children, believe in the educability of all children, possess a passion for science and math, have adequate research potential, express dedication to working with a team, and can commit to all aspects of the project for two years.

Guided by the discipline of the Fellows and the grade levels of the selected teachers, the recruitment team selects a pool of Fellows and alternates. Fellows are matched with teachers, giving consideration to personality traits, academic strengths, experiences, and interests. Fellows participate for up to two years, with teachers participating for one year to maximize outreach. Selection of Fellows in Years 2 and 4 is necessary only if there is attrition.

**Provisions for success with women, underrepresented minorities, and persons with disabilities:** Participation by women, underrepresented minorities, and persons with disabilities is encouraged in all recruitment and selection efforts.
Project Timeline

**Recruitment and Selection (RS) and Preparation:** Jan-May
- Recruit, select, match Fellows and teachers.
- Develop Summer Institute (Year 1); revise and refine Summer Institute (Year 2).
- Identify assessment instruments (Year 1); refine assessment instruments (Year 2).

**Summer Institute (SI):** June-August
- Fellows visit schools.
- Fellows receive training on standards-based instruction and attend LEP/SLD workshops.
- Fellows and teachers attend FOSS/STC/CMP workshops.
- Fellows receive training at field sites on using the sites to promote scientific inquiry.
- Fellows write/revise curriculum units with guidance from PI’s and RA’s.

**Fellows in the Middle schools (FM):** September-June
- Fellows observe classes and attend weekly meetings (September).
- Fellows, with teachers, deliver curriculum units, engage students in Field Experiences (October and April) and discuss possible revisions.
- Fellows present and districts review units (December and June).
- Fellows and students participate in Rainforest Connection (January).
- Fellows, teachers and students prepare for poster contest at Science/Math Day (ongoing).
- Fellows present seminars at Science/Math Day (May).
- Fellows and teachers attend monthly Professional Development Workshops.
- Fellows are visited and assessed by RA’s (monthly) and PI’s (Fall and Spring).

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**Interdisc. Theme**
- Earth History
- Planetary Science
- Populations and Ecosystems
- Chemical Interactions

**Suggested Field Sites**
- School of Conservation
- Dreyfuss Planetarium
- NJ Marine Science
- Liberty Science Center
- Sterling Mines
- Essex Env. Center.
- Great Swamp Refuge
- Intrepid Museum
- Liberty Museum