

RESEARCH INFRASTRUCTURE IMPROVEMENT (RII 4)
PROPOSAL DEVELOPMENT PROCESS

EDUCATION & OUTREACH WHITE PAPER

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TITLE: K-12 EDUCATIONAL PROGRAM

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The proposed EPSCoR program in New Mexico for addressing the Energy, Water and Environment nexus provides enormous opportunities to enhance science educational programs and outreach throughout New Mexico on these critical topics. Implementation of both targeted and widespread educational activities based on an environmental education/environmental literacy focus, described below, will create excitement for and academic improvement in science programs, as well as stimulate broad-based benefits in other disciplines that can be integrated with science-based environmental education. This program will also transmit the research results of EPSCoR's new scientific infrastructure and science faculty/graduate student activities to K-12 public schools, including students and teachers, as well as New Mexico's general population.

A growing body of research is demonstrating the enormous benefits of science-driven environmental education. Schools that adopt environmental education (EE) as a focus of their academic programs frequently demonstrate the following results:

- Better academic performance across the curriculum; reading, science, social studies, and mathematics scores improve;
- Students develop the ability to transfer their knowledge from familiar to unfamiliar contexts;
- Students “learn to do science” rather than “just learn about science”;
- All students have the opportunity to learn at a higher level;
- Schools have more support from parents, community and administrations.

Of particular importance for delivering on the promise of EPSCoR programs is the fact science-based EE—particularly “place-based” learning—creates enthusiastic students and innovative teacher-leaders, helps build critical thinking and relationship skills, and teaches students to be self-directed learners and real-world problem solvers. Environment-based education emphasizes specific critical thinking skills central to “good science”—questioning, investigating, forming hypotheses, interpreting data, analyzing, developing conclusions, and solving problems. And, just as importantly for meeting the challenge of promoting STEM programs, environment-based learning gets apathetic students excited about learning.

The overall K-12 education program goals will be to (1) increase the basic knowledge of New Mexico's student population on ecosystems, energy development, water resources and their environmental interactions, (2) develop teacher training and curricula materials on these topics, and (3) provide special targeted programs for advanced middle- and high-school students to expand and accelerate their science education, bringing them into the “pipeline” for college- and graduate-level science training. Special emphasis will be placed on tailoring these programs to the many rural school districts and charter schools in New Mexico, as well as to the local school systems serving New Mexico's Navajo, Apache and Pueblo Nations.

We propose to develop programs for EPSCoR-related information dissemination to students and educators in four general categories.

The first element of EPSCoR educational projects will be programs aimed at supporting and improving general environmental literacy and science classes (and their teachers) in schools across New Mexico. Without students mastering basic environmental literacy, the awareness and capacity of the general population to understand the “energy, water, and environment nexus” will remain crippled, and “STEM pipeline” for students in New Mexico will remain under-filled. The EPSCoR program will disseminate national and state-adopted environmental literacy standards, adapt and distribute existing curricula (or if necessary, develop new curricula), and share information on successful, existing NM science-based learning programs with field elements. This effort will promote focus on energy, water and environmental interactions for grade levels K-12. This effort will be supported by teacher trainings, to be held in various venues associated with field and laboratory research sites, including those equipped with EPSCoR infrastructure. In addition, EPSCoR will support field trips to augment the classroom instruction and enable “experiential” hands-on activities by the students and teachers. Such destinations for field trips would include diverse natural areas as well as electric generating stations, geothermal powerplants, production facilities for algal biomass, forested watersheds with biomass harvesting, rangelands and agricultural sites used for biomass production, university research laboratories, and so on. EPSCoR support for field trip logistics, including bus transportation and materials/supplies, would greatly facilitate the experiential programs. This program element has significant potential to achieve synergistic and catalyzing benefits by coordinating with other state and federal programs for science/EE efforts that are ongoing in New Mexico, as has the potential to positively impact a large percentage of the state’s 225,000 K-12 students and 84 school districts.

The second of these programs receiving EPSCoR support will be directed toward advanced middle-school and high-school science students through the Supercomputing Challenge Program and the Growing Up Thinking Scientifically (GUTS) Program at the Santa Fe Institute. Students will be introduced to computational modeling and complex systems through agent-based computational modeling. Using this technique, students as young as upper elementary students are able to develop models of complex systems by describing the interactions between agents and the environment and the between agents and other agents who populate the environment in a block based computer language. Local and regional cultural context can be an integral component of the computer models they create. Subsequently, students use the models they develop as experimental test beds to understand the behavior of the system they created. Emergent phenomena such as nonlinearities and feedback loops in systems can be observed and analyzed leading to greater understanding of complexity arising in systems comprised of many interacting interconnected elements or subsystems. New EPSCoR curricular units will be designed and developed to align with EPSCoR research on the nexus of water, energy, and environment. These units will be implemented through Project GUTS afterschool clubs and Supercomputing Challenge teams at New Mexico middle and high schools. Teachers who act as Project GUTS club leaders and/or Supercomputing Challenge team sponsors will attend professional development workshops thrice yearly to prepare for the implementation of the units with students. Within each unit we will incorporate a field trip where students can participate in experiential learning activities (field-work) and collect real-world data to analyze and compare with computer generated outcomes. The culminating activity in each unit will be students’ presentations of their research projects, models and findings at student roundtables and at the end of the year Supercomputing Challenge EXPO.

The third category of targeted audiences includes science students across New Mexico who participate in the New Mexico MESA Program (Math, Engineering, and Science Achievement) (<http://nmmesa.org/>). MESA students and teachers conduct many classroom, laboratory and field exercises during the school year, and have been active participants in many programs involving EPSCoR faculty and graduate students. During the new EPSCoR grant, specific projects will be developed to distribute to MESA programs state-wide, in collaboration with the MESA faculty and program officers. Included in these programs will be the necessary teaching materials and supplies, as well as web-based databases and lesson plans.

The fourth targeted educational audience will be the general population of New Mexico, with an emphasis on school-age children and their parents/immediate family. To reach this audience on a state-wide basis, the EPSCoR Program will initiate a multi-media campaign based on the data and results being generated by EPSCoR scientists and graduate students. Television and radio “spots” featuring students in hands-on activities with EPSCoR faculty and students will be produced and aired during morning/evening local newscasts, and during carefully selected television shows (e.g., the show with the largest audience of school-age viewers is “America’s Funniest Videos”). These spots will depict students discovering salient facts about energy and water, and their interactions, in their local communities. Following the air time, these spots will be available on the television web sites, as well as the EPSCoR website and local school/community sites. In addition, social media (Twitter, Facebook, etc.) sites will be set up to provide similar messages on important results generated by EPSCoR, yet designed specifically to appeal to school-age students.

Assessments and evaluations of all these programs will be conducted to determine their breadth of reach and effectiveness. We will assess the students participating in EPSCoR programs, comparing them to students who do not participate in such activities; as part of this endeavor, we also will gather teachers’ opinions on program effectiveness. For example, the New Mexico State Parks Department conducted teacher assessments of outdoor classroom environmental programs, and found >90% of teachers believed that the program was resulting in improvements in both their teaching abilities and the students’ classroom learning. For mass media efforts, statistical assessments will be made to evaluate information dissemination; for example, an Albuquerque TV station reports that running a 30-second television spot on the evening news once every 2 weeks for 9 months will result in 80% of New Mexico households seeing the EPSCoR student features an average of 5.5 times. Similar surveys will be conducted to assess web site impact and other social media effectiveness. Engaging both the students and their parents state-wide with mass media will expand considerably the ability to disseminate the EPSCoR science results to the public, and convey the salient points concerning energy, water and the environmental nexus.