The Clear Sky Experience: NASA Jumpstarts an Elementary Science Teaching Program. P. N. Holden and E. E. Faszewski, Department of Math and Science, Wheelock College, 200 The Riverway, Boston, MA 02215 (pholden@wheelock.edu; efaszewski@wheelock.edu).

Introduction: Teachers and scientists, concerned with the science performance of K-12 students in the U.S., have spurred national science education reform that is built on "learning essential science content through the perspectives and methods of inquiry." [1] In addition, this reform also stresses the importance of scientifically literate and well trained elementary teachers. Without specialized instruction, elementary age children inductively develop ideas about science and the workings of nature that can become entrenched and hard to overcome in secondary school[2]. In contrast, student outcomes on standardized science tests positively correlate with their teachers' level of content knowledge [3]. There is ample evidence to support the effectiveness of student engagement approaches and inquiry based education in general[4]. Thus, to produce students whose minds are open to new ideas, who are familiar with scientific inquiry, and who will be able to function in an increasingly scientific and technological world, it is vitally important to train elementary teachers with science specialization.

Most teacher preparation programs in the U.S. do not train elementary science specialists or have design short comings that would prevent adequate training of such specialists. Many programs emphasize pedagogical approaches with limited emphasis on science content, science concepts and scientific modes of inquiry. Other programs require science course sequences or even a science major but the science is often poorly coordinated with pedagogy. Collaboration, or even communication, between science and education departments is limited. Finally, many programs lack compensatory science instruction for the many students who enter teacher training programs with inadequate science backgrounds.

Progress: Wheelock College has moved forward with development of a training program to produce more scientifically skilled and knowledgeable pre-service elementary teachers. A science design team consisting of science and education faculty is creating this unique training program. The team has planned and begun implementation of the program working through NASA's NOVA Program (NASA Opportunities for Visionary Academics). An induction course for a new pathway through the math/science major ran for the first time this fall. The remaining courses of the new pathway, field experiences, and in service support will be implemented in following semesters.

The team is building on Wheelock College's strengths in education, science in support of education, and pre-service field experiences. The program will consist of several key elements all intended to directly address the limitations of other programmatic models for teaching elementary science specialists. Specifically, the program will incorporate (but not be limited to) the following key elements –

- An introductory course on scientific inquiry and critical thinking, research methods and experimental design, logical and deductive reasoning.
- A core sequence of introductory through advanced science courses focused within a discipline to develop a level of expertise and an appreciation for scientific research that comes from in depth study.
- Coordination of scientific content and pedagogical approach through science and education faculty collaboration as well as simultaneous scheduling of science and education courses.
- Student participation in Wheelock's renowned field experiences, often located at inner city schools with high minority populations. These field experiences culminate in a 300 contact hour practicum where students participate as student teachers involved in all aspects of K-6 classroom activity.

The scientific disciplines for student focus will be drawn from the areas of expertise of our faculty including earth and space science, environmental science, and biology. For breadth of knowledge students will be able to select from courses ranging from nutrition to marine biology.

We also envision outreach to schools for two essential purposes that further the goals of the Clear Sky Program. The first is to identify placements for program students that provide mentoring relationships in effective science teaching. The second is to support effective science teaching in the schools through our own expertise and ability to provide classroom resources. Outreach is necessarily an equal partnership with all parties benefiting. A large step forward in identifying potential partners was achieved through a

workshop on science education partnerships held at Wheelock College in December of 2005.

Visualization, Remediation and NASA: We pursued NASA's NOVA Program as a design platform for our Clear Sky Program after consideration of challenges faced. A large proportion of students interested in elementary education (and those entering college in general[5]) hold fundamental scientific and mathematical misconceptions and are intimidated by science and math courses. Rectifying misconceptions and changing student views of science is a considerable challenge in itself but is compounded by limited contact hours in science. To efficiently and effectively instill science content and concepts we realized that emphasis would need to be placed on visualization technologies and inquiry based educational approaches. Visualization for education has been employed effectively for remediative purposes [6] and is likely helpful for students whose breadth of content knowledge limits internal visualization.

NASA's NOVA Program offered an opportunity to design and implement our program in a relatively short time span by providing instruction, collaboration, and access to educational resources. It offered expertise with regard to inquiry based programs as well as resources for visualization technologies and applications. Thus, we were able to begin implementation of the Clear Sky Program less than ten months after our first NOVA workshop experience.

The first Clear Sky Program course to be implemented is entitled Science Inquiry and the Natural World. This is an environmental content course, a science inquiry course, and the induction course for the Clear Sky pathway through the math/science major. Persistently, throughout the course, students are challenged to identify and overturn preconceived notions of what science is and how it is carried out. They come to see science as the pathway to verifiable truth and come to appreciate the practical challenges of scientific studies. Students are also challenged to make connections between astronomy, earth science, biology, and oceanography and to see how interacting systems produce the natural environment. In an indication of student interest, the course was oversubscribed in its first offering.

Conclusions: The need for scientifically literate and well trained elementary teachers can be addressed through appropriately designed teacher preparation programs. It is possible to design and implement such a program in a short period of time given the following conditions:

- Forethought is given to the challenges and needs of the particular school and region where the program will be located.
- Government programs, granting organizations, individuals and/or collaboratives are identified whose goals coincide with the needs of the program to be created.
- Science and education faculty communicate extensively and work together collaboratively.
- The institution is patient with and supportive of faculty efforts.

We will continue to develop our Clear Sky Program with the expectation of turning out scientifically literate elementary school teachers. Once in practice, these teachers should have a greater likelihood of taking on leadership positions within their schools and providing assistance in science instruction to elementary generalists. The program, unique in New England, can serve as a national model for supporting elementary science instruction in regions and neighborhoods considered of high priority.

References: [1] NRC (1996) *NSES*. [2] AAAS (1990) *Sci. All Amer* [3] J Gess-Newsome (1999) *Electronic Journal of Science Education* [4] Smith et al (2005) *Journal of Engineering Education* [5]Higher Education Res. Inst. (2005) *Amer. Coll. Teacher, Nat. Norms 04-05* [6] Emigh and Zaslavsky (1998) *IEEE Conf.*