

The TRUST Partnership: Institutional Impacts at Lehman College

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This work explores the institutional impacts at Lehman College, City University of New York, of the Teacher Renewal for Urban Science Teaching (TRUST) Project, a partnership between the American Museum of Natural History and Brooklyn and Lehman Colleges funded by the National Science Foundation. We examine the impact that TRUST had and continues to have at Lehman College through its external partnerships, the evolving natural sciences-education cultural changes within the college, changes within the departments involved, and student outcomes and reflections.

THE TRUST PROJECT AND PROGRAM

TRUST, or Teacher Renewal for Urban Science Teaching, was developed as a formal-informal teacher education partnership between Brooklyn and Lehman Colleges of the City University of New York (CUNY) and the American Museum of Natural History (AMNH). The objective of the 4-year National Science Foundation (NSF)-funded program was to bring together the rich resources of AMNH with public urban teacher education for the promotion of Earth science teacher certification in New York City schools. Though no longer funded, TRUST is ongoing, having been designed as a sustainable integrated program at both AMNH and CUNY.

The program took a problem-based approach to reduced offerings and poor quality of urban Earth science instruction by identifying and targeting areas of

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extreme Earth science teacher shortage and high needs within the NYC public school system. Content relevance was assured by using the Earth science teacher certification knowledge framework published by the New York State Regents as the foundation for program content. Program design involved representatives from all stakeholder groups and also took into account the need for best practice instructional approaches that lead to improved student performance on high stakes assessments in Earth science.

With this problem-based approach at the core of the program, TRUST set out to achieve the following objectives (Macdonald et al., 2008):

- improve retention of new and novice teachers of Earth science;
- increase the number of certified Earth science teachers by facilitating and encouraging participants to obtain NYS teacher certification in Earth science within two years of enrolling in TRUST;
- improve the quality of Earth science instruction by enhancing teachers' knowledge base, confidence, and curriculum development ability;
- improve the quality of Earth science instruction in informal settings by preparing teachers to access resources available in science-rich institutions;
- prepare school administrators/teacher leaders to affect changes in their schools to facilitate and enhance Earth science instruction;
- accomplish attitudinal, structural, and political changes within the partnership institutions to successfully address identified problems in urban science education;
- document and evaluate the project's structure, procedures, and outcomes as an integrated replicable model.

Each of the colleges created a new graduate level geology content course designed specifically for educators. Articulated with these courses was a 60-hour summer institute at AMNH followed by an additional 10-hour series of AMNH lectures and activities (Figure 1). Teachers seeking Earth science certification and teacher leaders/school administrators seeking to improve science instruction in their schools were recruited as participants. AMNH supplemented the program by offering review sessions for the certification Content Specialty Test, Movable Museum visits to participants' schools, online learning seminars, multimedia resources, and access to AMNH resources and to the museum itself.

Participants were included in a growing network of TRUST Earth science educators through regular attendance at gatherings and targeted communication. Several participants were incorporated into the Advisory Board and in a variety of other "expert" roles once they had completed the program, helping to create a community of shared experience and expertise.

During the four-year funded period, 90 new Earth science teachers and 30 school administrators participated in TRUST; a community of Earth science educators developed and is still growing; and a sustained formal-informal

partnership program has been integrated into the structures of each of the partner institutions. The program's effectiveness was evaluated in terms of participants' professional development and changes within participants' classrooms and schools as well as the changes that occurred within the partnership institutions.

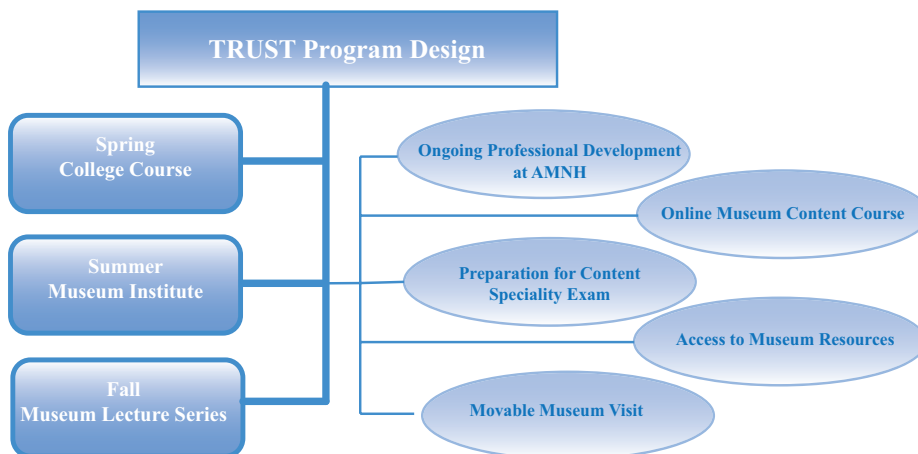


Figure 1. Schematic of the TRUST Program Design (after Macdonald, Sloan, Miele, Powell, Silvernail, Kinzler, Hong, & Simon, 2008).

Evaluation results indicated that the majority of participants sought and attained Earth science teacher certification following participation and that the retention rate for TRUST participants was significantly higher than for traditional or alternative programs leading to certification. TRUST participants reported a sense of enhanced content mastery and confidence in their instruction. Results also indicated that participants incorporated resources and materials available at science-rich informal institutions and maintained contact with AMNH by engaging in post-program professional development activities. Several participants demonstrated significant professional growth, presenting work at professional conferences, attaining higher degrees and advancing career positions. The sustained impact of TRUST within participants' classrooms and schools was remarkable. Programs like TRUST tended to have a substantial impact on participants' classrooms and schools in the first year following their participation, but in subsequent years this impact tended to decline. The impact of TRUST was shown to be substantial in the first year and continued to be sustained or was enhanced 2 to 3 years after participants completed the program. In the short term, there was an increase in the frequency of Earth science courses in participants' schools and an increase in the number of students taking the NYS Regents Examinations.

TRUST made lasting impacts on each of the partnership institutions. These impacts have taken the form of new programs and curricula, changing roles of staff and faculty, enhanced interaction within and between the institutions, and the development of new connections that reach beyond the original partnership. This work focuses on the lasting changes at Lehman College CUNY, and the continuing evolution attributable to the TRUST Project through an examination of partnerships with external informal science education institutions, the changing culture of collaboration between the education and natural sciences departments and faculty, development of new curriculum and programs, and the outcomes and experience of Lehman College participants.

EXTERNAL PARTNERSHIPS

Recent research has demonstrated the value of learning science in informal settings (Bell et al., 2009; Kisiel, 2010). Museums and science centers present an engaging context for teachers to make science accessible to a broader range of learners (Hofstein & Rosenfeld, 1996), by utilizing multimedia and natural habitats to appeal to the senses and inspire awe (Bell et al., 2009). It follows that teacher education programs should include approaches to science teaching in informal settings. This is best done through partnerships between formal teacher education programs and informal science education institutions.

The partnership approach to science education that began with TRUST engendered many valuable programmatic and informal opportunities for Lehman science education students to connect with external science professionals and access a wide array of institutional and community resources. One of the primary objectives of TRUST—to improve the teaching and learning of science for urban children—is being propagated through an array of newly developed formal-informal partnership programs with regional institutions.

Teacher education workshops have been piloted at several local science-based organizations. These workshops have been aimed at helping new and perspective teachers to communicate the relevance and complexity of the immediate surroundings to urban students. Groups of science education graduate students have experienced informal setting instructional approaches within the context of a required course entitled *Teaching Literacy Skills in Science*. The content and context of these experiences has changed with the evolving exhibitions and programmatic offering of the informal institutions. Groups have attended a week-long workshop at the Bronx Zoo, where they learned to cultivate students' scientific skills of observation and inference by participating in field studies of animals in their recreated natural habitats. Others have attended sessions at the New York Hall of Science in Queens, where they learned integration of literacy skill development and science concepts, primarily by experiencing the power of verbal expression

and nonverbal cues in teaching about scientific phenomena and promoting student discourse. Another group has attended a special program at the New York Botanical Garden in the Bronx, where they explored a replica of Emily Dickinson's garden while reading poetry inspired by her flowers. Finally, several groups of science education students have participated in a canoe trip down the Bronx River, observing the local ecosystem as a valuable context for learning about conservation, local geology, and the interdependence of wildlife. Lehman's ongoing relationship with each of these informal science institutions, inspired by the TRUST partnership, has greatly enhanced the quality of urban science teacher preparation and induction by leveraging and making accessible community-based resources.

DEVELOPING LINKS BETWEEN NATURAL SCIENCES AND EDUCATION

Research has suggested that the most effective teacher education programs successfully integrate the contributions of arts and sciences faculty and education faculty, resulting in the close alignment of subject matter training and clinical practice (American Council on Education, 1999). Teachers must be fluent in the conceptual understandings of their discipline (and the relationships among these ideas), as well as in the pedagogical content knowledge to generate appropriate metaphors and representations (Kennedy, 1998). Collaborations between the sciences and education are essential for modeling these competencies to novice teachers. In addition, the interaction between scientists and educators can be mutually beneficial. Scientists who have worked closely with new teachers have reported increased familiarity with key tenets of science education and best teaching practices, which are essential skills and knowledge for disseminating results of scientific research to lay audiences, as well as their own post-secondary students (Caton et al., 2000). Scientists and teachers share the goal of developing the scientific literacy of their students and of stimulating their interest (Taylor et al., 2008). The TRUST project sought to cultivate these common objectives through sustaining and expanding collaborative science teacher education at Lehman. The success in achieving this goal contradicts the tendency of such partnerships to cease after the grant-funded period has ended (Rooney, 1995).

TRUST has had a sustained impact on improved connections and collaboration between the Divisions of Education and of Natural and Social Sciences. The post-TRUST improvement in natural science-science education culture has resulted in the collaborative development and teaching of courses in science and science education, cross-over of faculty, cross-divisional teaching and coteaching of graduate and undergraduate courses, cross-divisional faculty peer mentoring, and collaborative bids for external funding for research and programmatic initiatives.

CURRICULAR IMPACTS

The influence of the TRUST Project has resulted in several programmatic and curricular changes in the Department of Middle and High School Education (MHSED) and in the Department of Environmental, Geographic and Geological Sciences (EGGS). Two new graduate-level courses in the EGGS Department were developed, proposed, and approved by CUNY and the New York State Education Department: GEO 601 *Earth Systems Science for Educators* and GEO 697 *Independent Study* (Figure 2). Earth Systems Science for Educators models pedagogic approaches and field work in parallel with Earth systems science concepts. Modeling of pedagogic practices is found to be valuable when integrated into content teaching at multiple levels in order to establish a well-defined pedagogical content knowledge model of instruction (Darling-Hammond & Bransford, 2005; Kind, 2009; van Driel et al., 2001). The new variable-credit *Independent Study in Geology* was designed not only to function as a traditional independent student research project course, but also to offer formal college credit to students enrolled in the TRUST *Summer Institute for Earth and Space Science*, the Fall Lecture Series, and similar programs at other informal science education institutions.

Building upon the success and popularity of the new geology and earth systems courses, Lehman faculty have continued to improve offerings for teachers of other science disciplines. The TRUST project has inspired enhanced integration of science and education as a means to improve the content expertise and pedagogical content knowledge of in-service teachers. In the Department of Biological Sciences, teachers may enroll in courses that have been developed specifically for them: *Economic Botany* and *Genetics*. In response to the requests of numerous teachers, the department has recently revived *Principles of Ecology*, a course that had not been taught in some years. This course has been particularly useful for biology teachers due to the increased emphasis on ecological systems in the New York State *Living Environment Curriculum*.

Remarking on the success and popularity of *Earth Systems Science for Educators*, other Natural Science departments have embraced collaborative, interdisciplinary offerings aimed at fulfilling the needs of secondary teachers. The Department of Physics and Astronomy piloted *Physics for Educators* last year, co-taught by Kelly and a faculty member in Physics. The co-teaching model brings together the expertise of faculty in science and education to improve science content knowledge while modeling best practices in science pedagogy. The Department of Chemistry initiated courses with a chemistry education focus and offered teachers the opportunity to do summer research projects working alongside chemistry faculty for independent study credit. They also created a special topics graduate course where teachers design research-based experiences for students and actually

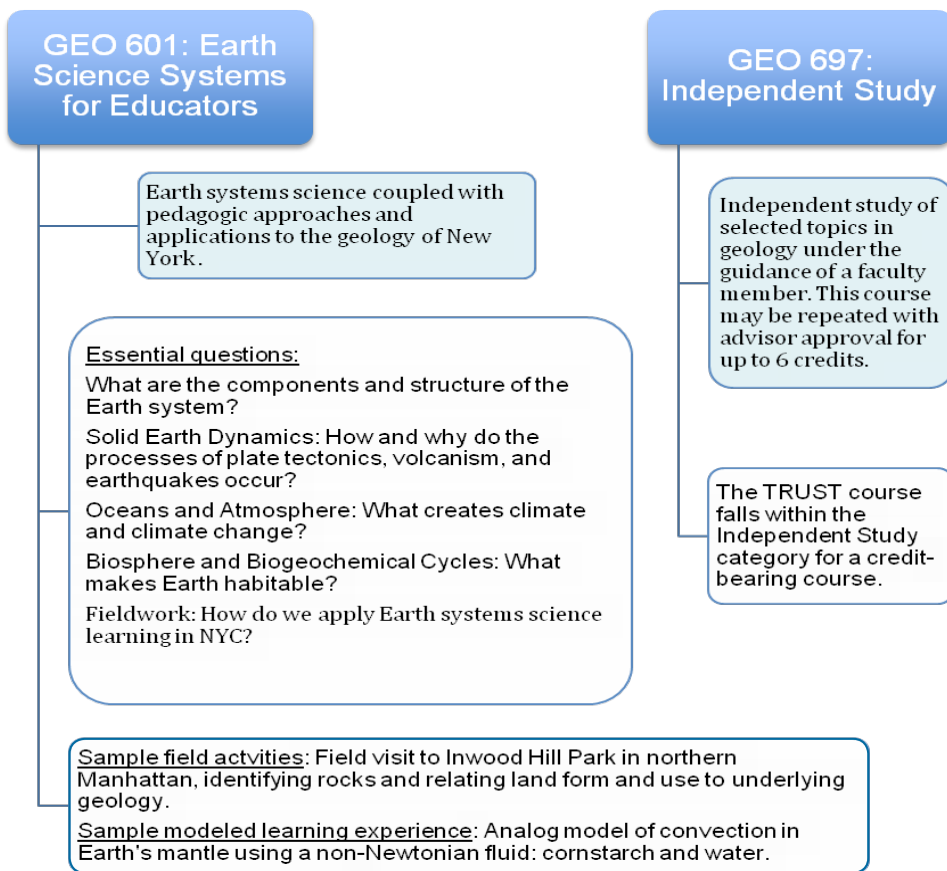


Figure 2. Institutionalized course development at Lehman as a result of the TRUST project (after Macdonald, Sloan, Miele, Powell, Silvermail, Kinzler, Hong, & Simon, 2008)

teach introductory chemistry labs to Lehman undergraduates. These exciting initiatives have all been influenced by the success of the original TRUST project.

The TRUST initiative served as a springboard for the continued pursuit of NSF grant funding to improve science teacher education at Lehman. Several Lehman science and education faculty have collaborated on the NSF-funded Robert Noyce Scholarship Program, where additional resources are designated for the development of co-taught classes in science, mathematics, and education. The first such course, *Integrating Mathematics, Science, and Technology in Middle School Teaching and Learning*, is co-taught by Sloan (one of the TRUST co-PIs), Kelly, and a faculty member in Mathematics Education. This collaborative effort aligns content with professional standards to design inquiry-based projects for science and mathematics curricula, and to model the delivery of effective cross-disciplinary middle school instruction.

Student Outcomes

Recent reports have stressed the persistent need for high-quality science teachers in urban districts such as New York City (Coble et al., 2006; The City Council of the City of New York, 2004). During the 2007-2008 academic year, 16% of NYC science teachers did not have appropriate disciplinary certification; teachers who were not “highly qualified” staffed 4.8% of all biology classes, 6.0% of chemistry classes, 16.5% of Earth science classes, and 10.9% of physics classes (New York State Education Department, 2008). The persistent need for more Earth science certified teachers was the primary motivation for the TRUST project.

The data in Figure 3 reveal the number of Earth science certified teachers from Lehman College from 2003–2007. One of the primary objectives of TRUST was for participants to seek Earth science teacher certification within two years of their participation. During the grant-funded period of the program from 2003 to 2006, three cohorts were recruited: the first in 2004, the second in 2005, and the third in 2006. Since the end of the grant-funded period, *Earth Science for Educators* and the AMNH *Summer Institute for Earth and Space Science* was offered in 2008 and 2010 and will continue to be offered every other year. Earth science teacher certification rate doubled in 2004, the first year of the TRUST program. The two following years saw a decline in the certification rate. In 2007, within two years of the entry of the 2005 cohort, there was an additional 63% increase on top of the 2004 gain for an overall increase of 225% since 2004. Certification figures for more recent years are not yet available.

Participant Role in Dissemination of the TRUST Project Model

Over the course of the four-year funded period, numerous presentations disseminating information about the TRUST project were made at several national and international professional organization conferences including ones in geosciences, teacher development, informal education, and science teaching research. Lehman College TRUST participants attended national and international conferences accompanied by the investigators, further expanding their professional experience and career accomplishments. Many of these conference presentations and their accompanying proceedings publications included participants as presenters and co-authors. For example, Sloan co-authored a presentation and abstract with participants Drantch and Steenhuis (2006) at the American Geophysical Union, *TRUST: A Successful Formal-Informal Teacher Education Partnership Designed to Improve and Promote Urban Earth Science Education*. In addition to enhancing Lehman’s reputation in the larger world of geoscience teacher education, this experience increased the participants’ sense of professional identity and provided them with opportunities to learn and interact with teachers and scientists outside their immediate communities. Reconvening of the original cohorts at

AMNH will continue to strengthen network ties, enhance the sustainability of the original TRUST experience, and inspire participants to disseminate the project's influence through their collaborative efforts.

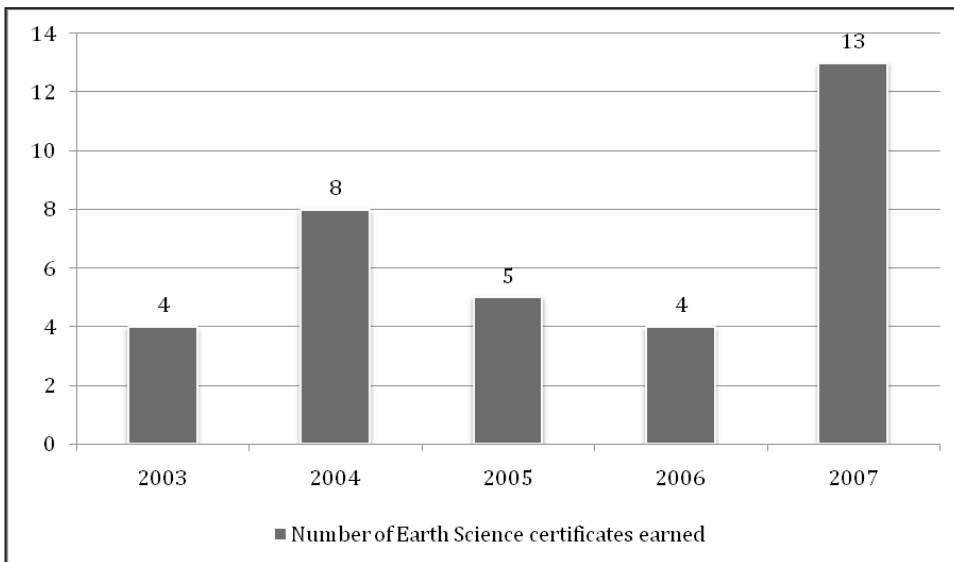


Figure 3. Science teaching certificates earned by Lehman College students (2003–2007)

Confidence and Satisfaction

Evaluation of TRUST program showed an overwhelming increase in Lehman participant' satisfaction and confidence. According to Lehman College TRUST participant reports, they acted as a resource for other teachers in their schools, and their involvement in the program improved their schools' science programs (Macdonald et al., 2008). For this article, delayed post-survey responses were collected from a select group to assess long-term impacts on the science teachers. The data, described below, reveal that the program was instrumental in making teachers more comfortable with their content, the interactions with scientists provided authentic contexts for learning science, and teachers were committed to continuing careers in science education.

Since many of the teachers involved in TRUST were new to the profession, they often experienced a lack of confidence with the curriculum content. This was particularly true with those who were trained in another discipline and were transitioning to Earth science. One participant who made such a transition shared how TRUST influenced her teaching by providing access to physical examples of the scientific concepts in her curriculum:

As an educator with a scientific background in physics rather than geology, TRUST really helped me to become more comfortable with the curriculum I'd already spent one year teaching. I felt much more comfortable explaining the processes that shaped our planet, and much more confident that I had physical evidence that I could point to. As an example, I learned how I could use the banded-iron formation to explain the oxygenation of Earth's atmosphere, and could point to samples of stromatolites to show how organisms brought about this change.

The Museum exhibits provided her with a means of engagement that she could share with her students, even if they were not present in the physical classroom space. She was able to strengthen her own sense-making of geological phenomena and to convey those understandings to her students.

Another benefit of the TRUST program was the interaction with geologists engaged in research. One teacher's experience with TRUST extended beyond the physical Museum environment to sharing in authentic scientific practices initiated by the Museum scientists:

Being able to interact with samples of the three main kinds of rock, to see the physical structure of igneous, the distortion in metamorphic, and Hutton's famous outcrop of sedimentary rock make the rock cycle so much more present for me. TRUST helped me understand how practicing geologists use good practices in the field to collect data to be analyzed in a lab. The only labs I had been used to were small telescope observatories, so the immediacy of fieldwork appealed to me... It was refreshing to feel connected to scientists producing new studies, and the Institute really opened my eyes to the incredible opportunity educators have to use museums to inspire learning.

Her experience with actual scientists transformed her understanding of the value of science in analyzing the natural world. She further commented on feeling like a "stakeholder in the greater dialogue of science," and she was encouraged to bring this enthusiasm back to her classroom. TRUST helped her feel an identity with science that she had not previously internalized, and she was determined to inspire in her students a sense of belonging in the global scientific community.

Participants reported that the impacts of TRUST extended beyond their first year of engagement with the program, and it inspired them to pursue various types of further professional development and extend their commitment to education. One former participant in TRUST commented on the potential of informal settings to promote life-long science learning, and how she valued assessment data to inform and improve her teaching practice:

It is imperative that we as pedagogues and educational researchers—both in formal and informal settings—learn how to preserve and bolster in students the spirit of science: a curiosity, a passion, and a willingness to try and fail. I intend that [my] work is only the beginning of a larger project to use structured interviews and journals to evaluate science museums and other informal centers of science learning.

Another comment suggested that TRUST was instrumental in sustaining the participants' commitment to science education:

It is safe to say that taking the *Earth TRUST Institute* solidified my current career plans in education. TRUST transformed my enthusiasm for teaching in general and geology in particular.

The sustained impacts of the TRUST model suggest that its success is ingrained in the professional lives of the participants, who acquired deeper scientific understandings, engaged in authentic research practices, and renewed their commitment to educating urban children in the wonders of Earth science.

SUMMARY

The TRUST project succeeded in providing a problem-based approach to urban science teacher shortages by focusing on the knowledge required for Earth science teacher certification and the need for instructional approaches that lead to improved student performance on high stakes assessments in Earth science. This success lies not only in helping participants to become state certified, well-prepared, confident, better-satisfied Earth science teachers able to incorporate informal science resources and settings into their practice, but also in the impacts the project had and continues to have on the partner institutions. The institutional impact at Lehman College includes newly developed courses in Lehman's science education, geology, chemistry, and physics programs in which content and pedagogic skills are fostered in parallel. These teacher-targeted courses currently host nearly two hundred secondary teachers in the Graduate Program in Science Education. New partnership initiatives have sprung up between Lehman's science education program and several NYC science-rich informal institutions, further enhancing experiences of new and novice science teachers at Lehman. These partnerships are at the very least informed by, if not a direct result of, the ongoing success of the TRUST program. New collaborations and a new spirit of collegiality have greatly improved the relationship between Lehman's science education and natural science programs. The TRUST formal-informal science education partnership between Lehman College, CUNY, and the American Museum of Natural History has had sustained impacts on Lehman College resulting in significant improvements in the science

education program, natural science-education collaboration, and relationships with other informal science education institutions making TRUST a successful partnership model worthy of replication.

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