Standards-Based Enhanced Academic and Professional Training for Geoscientists*

Final Project Report

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Abstract: This project enhanced the content and delivery of four existing courses with standards-related learning opportunities. The four courses which have been offered through the Department of Earth and Atmospheric Sciences, City College of New York, City University of New York, are Phase I environmental site assessments, Phase II environmental site assessments, Global Environmental Hazards, and Seminar on Science and Technology in New York City. The latter course is cross-listed by the Macaulay Honors College of the City University of New York. This project also informed the content and delivery of standards-related courses at the College of Global Public Health, New York University, and the Sustainability Management graduate program, Columbia University, including professional training specific to the employees of the New York City Transit, Metropolitan Transportation Authority. At the time that the present report was authored the following teaching modules -out of the original nine that were proposed- are thought to hold a higher promise of being adopted by additional institutions: environmental site assessments standards, environmental management standards, mold assessments standards, and building standards for earthquakes.

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Introduction

CCNY was one of five institutions receiving funding in 2016 from NIST out of forty-nine applicants. The purpose was to develop teaching materials for integration into four courses encompassing topics such as environmental management standards, mold standards following hurricanes, environmental site assessments, the effects of international trade agreements on safety standards, building standards for mitigating the effects of earthquakes, mining standards, geographic information metadata standards, and standards for first responders regarding chemical and biological substances.

Of these four courses, two are offered in sequence on the topics of Phase I and Phase II environmental site assessments. The CCNY bulletin description on these two courses reads almost verbatim from ASTM E1527, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, and ASTM E1903, Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process, respectively. The Phase I course has been offered every fall semester since 2010, and the Phase II course has been offered every spring semester since 2011, both at the undergraduate and graduate levels. A third course entitled Global Environmental Hazards focuses on the study of important, naturally occurring, destructive phenomena, such as earthquakes, volcanic eruptions, landslides, and coastal flooding. Related topics include long-term causes and remediation of these problems, as well as a focus on consequences to urban environments. Finally, the fourth course is specific to CUNY's Macaulay Honors College students, who come together for a seminar course that they take over the course of their second year. This seminar course is called Science and Technology in New York City.

Project importance, approach, and student participation component

NIST funds facilitated the development of teaching materials sufficient for the equivalent of nine weeks of teaching. The academic semester at CCNY follows the universal academic calendar that is shared among the twenty-four campuses of CUNY. Teaching time for a three-credit course is typically distributed over fourteen weekly meetings of 2.5 hours each, or twenty-eight meetings of 1.25 hours (i.e., two meetings per week.) Overall, the academic semester consists of fourteen weeks, excluding the final exams week and reading periods. Certain elements of these teaching materials were already underway prior to the NIST grant, while others were realized during the project period. Interested educators may potentially adopt stand-alone topics or expand on a short sequence of topics as it best fits their needs.

The relative importance of this project can be viewed in the context of the wider curriculum development efforts in STEM disciplines over the last few years. Next to the occasional success stories, a quick review of curriculum development efforts in the STEM disciplines reveals the level in which the literature is littered with unsuccessful or partially successful attempts to increase the students' understanding and appreciation of science, technology, engineering, and math. There is good reason for the great number of frequently unfulfilled curriculum development efforts in the STEM disciplines.

First, curriculum development is a painstakingly slow process. By the time the effort is complete market trends may have already shifted, effectively decreasing the relevance of the original idea. This is especially true for educational efforts that include elements of standards and standardization, which can have a particularly narrow focus in terms of the number of standards and associated industries under evaluation. Second, inevitably, a great number of proposed efforts, including those that may have been locally successful, rely heavily on the unique expertise of the principal investigators involved, making it almost impossible for other educational programs to replicate their model. Finally, the increased reliance of curriculum development efforts on web-based applications, although it ensures in the short term the widest possible visibility of the proposed models, makes the approach unsustainable in the long term. This is due to the maintenance required for the continuous optimization of most, if not all, web-based applications in the ever changing environment of online platforms and personal devices.

Our approach for this project has had the following characteristics: (1) Maintained a strong focus on the relevance of the standards highlighted through the project with the geosciences and engineering fields. (2) Strived to achieve a balance between the ephemeral aspects of the proposed project and its long-term objectives, ensuring sustainability of the application of our model within the respective institutions of the authors of this project and beyond. (3) Focused to an as wide as possible collection of standards, multiplying the relevance effect to larger communities.

In the development of the teaching materials there was a strong student participation component. Eight students were selected and received a form of fellowship based on NIST funds to assist in the literature review, content organization, and preliminary editing. A particular effort was made to attract students exposed to standardization and in some cases further train them in standardization through various opportunities presented during the project. For instance, one of the graduate students involved in the project, Karmin Chong, was 1st place winner for American National Standards Institute (ANSI) and its Committee on Education (COE) annual national student paper competition in 2016. Several of the undergraduate students involved in the project, specifically Shirley Chen, Sabrina Cohn, Maria Cogliando, and Orian Painter, also participated in one of both of the standards development simulation exercises organized by the ANSI at San Jose State University in Santa Clara, CA, on October 27th, 2017, and at Washington, D.C., on October 15th, 2018.

Original Project Goals

The original project goals were aligned with the development of teaching materials for integration into four courses that included the following topics:

(1) The Metropolitan Transportation Authority (MTA) of New York City Transit (NYCT) as a case study of the first public transportation company in North America certified to ISO 14001:2015, Environmental management systems - Requirements with guidance for use.

(2) Focus on mold standards using as a case study the aftermath of Hurricane Sandy that was developed in late October 2012 and impacted over sixteen states, including power outages for more than 8.5 million residences and 380,000 homes destroyed or damaged. New York City's guidelines on assessment and remediation of fungi in indoor environments, OSHA's "A brief guide to mold in the workplace," EPA's "Mold remediation in schools and commercial buildings," FEMA's "Cleaning flooded buildings," as well as IICRC/ANSI S520 Standard for professional mold remediation (third edition, 12/8/15) were the relevant included in this module.

(3) and (4) Introduce good commercial and customary practices in the United States of America for conducting Phase I and Phase II environmental site assessments using ASTM standards E1527 and E1903.

(6) Building standards using a case study the aftermath of 2010 earthquake at Port-au-Prince, Haiti.

(7) Mining standards in the US and internationally: The case of Latin American mining.

(8) The use of Geographic information metadata standards in the development of databases in support of resilient and sustainable growth.

(9) Standards associated with the neutralization of and decontamination from chemical and biological warfare agents.

Project Evaluation and Assessment

The curriculum components developed through this project were field-tested in real classroom environments. Student feedback was documented via anonymous surveys that were administered through the "Blackboard" course management system. The final review of the material was concluded at the end of the fall 2018 semester. We present here survey data from the delivery of eight modules that were realized during the spring 2017 academic semester. Over the course of 2.5 hours the eight modules were presented in fifteen-minute sections before a class of ninety-four undergraduate students enrolled in the Global Environmental Hazards course. Of these ninety-four students, sixty-two are majoring in civil engineering, eighteen in the environmental earth systems science program (i.e., an interdisciplinary program of the CCNY Division of Science and the CCNY Grove School of Engineering), three in geology, three in chemical engineering, one in biomedical science, one in psychology, and six had not yet declared a major. The survey was anonymous and recorded a total of eighty-four responses. Survey statistics on the question "Was any of the information presented in this module new to you?" are presented in Table 1.

Table 1: Was any of the information presented in this module new to you?					
	Never exposed before	Have a little prior experience with this	Have a fair amount of prior experience with this	Have a lot of prior experience with this	*Unanswered*
Building standards and earthquake hazards (Haiti case study)	8.75%	53.75%	32.5%	5%	0%
Mold standards and post hurricane Sandy resiliency efforts	25%	50%	23.75%	1.25%	0%
Phase I environmental site assessments standards	36.25%	50%	10%	3.75%	0%
Phase II environmental site assessments standards	43.75%	45%	8.75%	2.5%	0%
OSHA safety standards: NYC to Bangladesh	33.75%	47.5%	13.75%	5%	0%
Mining standards in the USA and internationally: The case of Latin American mining	53.75%	38.75%	5%	1.25%	1.25%
Environmental management standards (NYC MTA case study)	61.25%	27.5%	10%	0%	1.25%
Geographic information metadata standards	58.75%	31.25%	8.75%	1.25%	0%

Overall, the survey results indicated that the majority of students had little to no prior exposure to those modules. Survey results also confirm some of the demographics described above. For instance, it comes as no surprise that a class of sixty-two civil engineering majors out of ninety-four undergraduate students had a little prior experience with building standards at 53.75 percent and a fair amount of prior experience with building standards at 32.5 percent (or a combined 86.25 percent.) Civil engineering majors in great numbers in this particular class may also explain a solid 88.75 percent who found building standards as “very relevant” on the question “How relevant do you think this lecture is to authentic real-world activities?” (see Table 2).

Table 2: How relevant do you think this lecture is to authentic real-world activities?				
	Not at all relevant	Neutral	Very relevant	*Unanswered*
Building standards and earthquake hazards (Haiti case study)	1.25	10	88.75	0
Mold standards and post hurricane Sandy resiliency efforts	0	20	80	0
Phase I environmental site assessments standards	0	21.25	78.75	0
Phase II environmental site assessments standards	1.25	16.25	82.5	0
OSHA safety standards: NYC to Bangladesh	0	30	70	0
Mining standards in the USA and internationally: The case of Latin American mining	0	42.5	56.25	1.25
Environmental management standards (NYC MTA case study)	0	37.5	62.5	0
Geographic information metadata standards	1.25	40	58.75	0

On the relevance question the results presented in Table 2 were very encouraging with all modules crossing the fifty percent mark and most of them scoring strong majorities among surveyed students for topics being "very relevant." It is also worth noting that these modules were not delivered by professional educators, but by four students supported under the NIST grant, two graduate students and two undergraduates, respectively.

Additional surveys were conducted in three other courses, which are not presented in this report. The main conclusion in our standards-based curriculum efforts through this project is that the CCNY approach largely met the relevance requirement as far as our student population is concerned.

Project Outcomes

For the proposed nine topics, we developed the following components: (a) Power Point presentations; (b) Training and reference materials library; (c) Short interviews recorded in video-podcast format featuring members of the standards community; (d) Instructor guidance document consisting of instructions for preparation, lesson plans, slide notes for the Power Point presentations, student handouts, and a collection of suggested in-class activities and homework assignments; (e) A bank of test questions and answers.

Findings, Lessons Learned, and Potential for Knowledge Transfer

In the process of researching and developing the teaching materials outlined above it became evident that some of the modules would have limited potential as stand alone topics given the steep learning curve that would be required for successful implementation. Of the nine modules listed in the previous section, topics 7, 8, and 9, seem to be less promising for wider adoption. On the other hand, professional and other developments unrelated to the project but occurring during its implementation proved to have a reinforcing effect in terms of the knowledge transfer potential of the teaching materials. Of those developments, the two most important ones were the transition of Jack Caravanos to the College of Global Public Health, New York University, and the 2017 book publication of Thomas Abdallah's Sustainable Mass Transit by Elsevier. Chapter 9 of this book is on Environmental Management Systems and directly overlap with our project components. Both collaborators also represent early adopters of the finished modules beyond the City University of New York.

Another lesson learned based on our preliminary interactions with potential early adopters, including educators from neighboring states, is that the dedicated website solution is not particularly appealing. Instead, we plan on holding annual meetings based on the model of a collaborative STEM education network similar to the one utilized by Bower et al (2014.). In this respect, we plan on alternating meeting locations annually, between the campus of City College of New York, New York University, and of the downtown headquarters of the MTA in New York City. During these meetings that we will run as workshops interested faculty from across our region can hear from the primary authors directly and test in real time the teaching components developed by this project.

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