Final Report

NIST Standards Services Curricula Development Cooperative Agreement Program

"Establishing Freshman to Senior Bookend Experiences to Provide Academic and Professional Introductions to Standardization"

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This final report summarizes all the work performed on the project, from the first step of initial development of content for lecture materials, through the delivery of lectures in both the freshman and junior/senior courses, to the presentation of results and the program at two events, then finally culminating in the development of this report.

Step One: Development of Content for Lecture Materials

Content development for the lectures began with the review of standards-focused websites of the discipline-specific professional associations that match the engineering majors available at UNC Charlotte. In addition, the PI researched the basics of learning standardization as they are currently presented on the ANSI and ISO websites to determine what materials are easily transferable and referenceable to the classroom environment. Finally, materials on the NIST site were reviewed to find materials to blend into the discipline-specific association materials and more generic ANSI/ISO materials.

The next critical step was working with the freshman level ENGR 1202 instructors in the four disciplines and the junior/senior level ENGR 3295 professional development instructor to discuss content development and to solidify their time and content commitments to the course. Meetings were held with each of the coordinators of their respective courses at the freshman (Engineering 1202) and senior (Engineering 3295 professional development) levels to discuss objectives and obtain ideas regarding standards that are important to each majors' development. In addition, the PI took over the senior design coordinator position for Systems Engineering (started in this position during Fall 2014 and likely continuing well beyond the end of this project), so it is possible to work closely with the other senior design coordinators within the other engineering majors. This assignment to senior design coordinator was a fortunate coincidence rather than planned as part of the grant. Within senior design at UNC Charlotte, some requirements already exist for documenting standards referenced within the projects, but more specific materials and links with richer content highlighting the importance of standards and how to find them should have been added to the extensive materials that have been developed to guide the conduct of the senior design courses.

Building upon the previous meetings with the ENGR 1202 course coordinators in each of engineering disciplines at UNC Charlotte (Civil, Electrical, Mechanical, Systems) and the ENGR 3295 professional development instructor, the next critical step as identified in the proposal was to recruit and manage a student during the year to assist in the development of discipline-specific content that would be attractive from a student perspective. Rather than hiring a single student for ten hours per week during the entire academic year, the PI recruited and hired five discipline specific students (see photo below) to work five to ten hours per week during the Fall 2015 semester.

Three students were Mechanical Engineering majors, one student was a Civil Engineering major and one student was from Systems Engineering. Of the three ME students, one had significant experience from an internship working on electrical engineering related work, so he was selected because of the lack of acceptable EE applications. The other ME student had a strong interest and experience in Chemical Engineering, so he was selected to provide content outside of the four disciplines currently at UNC Charlotte. The students worked from September 2015 through December 2015, developing content focused on 2-3 specific examples of standards within their scope area. The PI met with the students in a weekly sharing session so they could see each other's work and talk about their strategy for the upcoming week's development. Files were openly shared and available through a DropBox account. The students submitted their content to supplement the materials developed by the PI that were focused more on the ANSI/ISO processes. The broader background and variety of perspectives was a much better choice, plus the students worked together as a team rather than a single student providing their single perspective. The students' overall five hour work weeks consisted of the one hour meeting

with the PI, a one hour meeting with each other (providing the PI with meeting summaries), plus three hours performing their research. By the end of the Fall 2015 semester, the students produced a common look and feel for a set of discipline-specific modules to use in the courses targeted in this project. The students were great resources to judge how various types of standards content will catch their fellow students' attention. They were, however, challenged by a lack of PowerPoint experience and presentation layout skills. The initial sets of slides provided by the students tended to look like a ransom note of cut and paste pieces. The PI was able to work with them to develop a better overall flow and look to the materials. This was an unexpected side benefit for the students.

Structure of the Five PowerPoint Presentations

The PI developed five presentations using a core set of slides focused on answering eight fundamental standards-related questions to be presented to the students during the freshman level, discipline-specific ENGR 1202 courses and the junior/senior level ENGR 3295 professional development course.

The eight core questions are:

- Who develops standards? [making the point that it is them, once they have experience]
- What is ANSI? [to understand the facilitator and traffic cop role vs. the developer perception]
- What is ISO? [to understand the similar international role and ANSI connection]
- Are standards law? [to understand voluntary, consensus building, but possible requirement]
- How long does it take? [to understand process steps generally and the 1-5 year cycle]
- How many standards are there? [asking students in terms of power of 10 magnitude]
- What discipline-specific professional organization is connected to the student?
- Where can you find standards? [primarily point to NSSN, but other resources as well]

Each of these questions were developed to open a conversation about standardization and remove typical perceptions the students tend to have as freshman, particularly that an all-knowing set of people in Washington or some large European city develop standards and tell everyone what they must do.

A variety of other points were made regarding topics such as performance vs. prescriptive standards and the importance of understanding should vs. shall. The presentations included a few standards that might be familiar to them (USB drives, oil grades, Wi-Fi, etc.) that were discipline specific. Then the lecture presented them with organizations they may recognize (for each discipline, using the primary professional associations they know such as ASCE, IEEE, ASME, and IISE) that develop standards. Next, students learned about ANSI and the general standards development process. Then the students learn about ISO and the international standards development process.

All four discipline-specific ENGR 1202 presentations, plus the ENGR 3295 presentation were made during the Spring 2016 semester. The students took a pre-test that was administered similar to a pop

quiz at the start of the class (pre-test and post-test example files are provided along with this report). The students then listened and interacted during the lecture portion. The classes ended with them retaking the same pre-test questions as a post-test. All the questions and the process were approved by the UNC Charlotte Institutional Review Board (IRB).

The number of students in each of the ENGR 1202 discipline-specific courses in the Spring 2016 semester were:

81	Civil Engineering
99	Electrical/Computer Engineering
171	Mechanical Engineering
35	Systems Engineering
386	TOTAL ENGR 1202 Students

The lecture for the junior/senior level ENGR 3295 Multidisciplinary Professional Development course had 208 students in the Spring semester. Although the lecture currently contains significant overlap with materials in the ENGR 1202 lecture, additional emphasis was made in the ENGR 3295 Professional Development course on how to find standards, use them in their work, and become involved in the standards development process for their professional development and for the good of their own organizations. They will better understand how standards work can help them become better technically, broaden their network, enhance their people skills, open more career opportunities, and see more of their country and the world.

Presentations at Standards Related Events, NIST Grantees Workshop and ASEE's CIEC Conference

The first event that the PI participated in was a two-day event in Washington, DC focused on standards in the supply chain that was hosted by NIST at Georgetown University. The second event was a workshop session on standardization in the physical internet at the 2nd International Physical Internet Conference (IPIC 2015) held in Paris in the summer of 2015. Neither of these events were funded through this NIST cooperative agreement, but were influential in the materials, particularly related to systems engineering.

The PI attended and presented at the 4th Annual Standards Education Workshop held at NIST in Gaithersburg on November 4th. A copy of the presentation slides was already made available to the attendees by NIST. The PI covered goals, significant accomplishments, status, and plans. The PI also provided an overview of the valuable help provided by a small, 5-person, undergraduate development team, introduced the attendees to the primary questions to be asked/answered in the courses at UNCC, and provided a representative sample of the slides used in the courses, plus a detailed demonstration of the flow of information to help the students become interested in the role of standards in their education and their careers.

The PI attended and presented at ASEE's 2017 CIEC conference in February 2017. This was felt to be a great option to reach a good audience of fellow teachers plus industry participants that would have an interest in how to make the connections between the standards development world and academia. A presentation titled, "Partnering with NIST to Provide Standards Essentials in Four Disciplines" was provided on February 8th to approximately 30 people in a multi-presentation session titled, "Expanding Academic Partnerships and College Relationships." The PI provided an overview of the purpose of the NIST cooperative agreement program (borrowing content from several slides from the Annual Standards Education Workshop) and this project's role in that program. Also provided were an overview of the project goals, structure, and results to date. A copy of the slides is provided with this report.

Lack of Progress on Development of an Online Materials and Testing Repository

The PI desired to develop a long-term resource for faculty wanting to include modules in their classes related to developing a better understanding of standardization and its role in their education and profession. The tool was to provide the capability to register faculty and their students, have the students download and review the lecture materials, then provide the selection of questions from a question bank based on the faculty person's goals. Faculty would then be provided with a report that would show the students' registrations and scores on the online quizzes. The PI hired a computer science graduate student with proven experience in building databases and applications. Seven meetings were held to develop the structure and review the early prototypes. Part of this material was presented at the NIST workshop. Unfortunately, the graduate student returned to India due to some family issues, then returned unable to continue the project as he finished his education and found a permanent position. This capability was unfortunately not developed as part of this project's accomplishments.

Although a website and sharing facility was not created to be housed at UNC Charlotte as part of an ongoing resource for future teachers, the five lectures are provided along with this report.

Analysis of Data for Pre-test and Post-test Materials for the ENGR 1202 and ENGR 3295 Courses

As previously stated in the September 2016 report, presentations were made to each of the ENGR 1202 discipline-specific courses in Spring 2016. Before each lecture, the students took a paper-based, pre-lecture quiz to determine their level of basic standards development knowledge. Then a presentation was made covering the purpose of standards, a wide range of standards and standards development resources, and how standards are developed. Following the presentation, the last five minutes were used for a retake of the pre-lecture questions to see what knowledge they may have gained. The PI found that the analysis of results from the pre-lecture and post-lecture quiz responses were not amenable to statistical analysis due to the nature of the questions that were asked. As a lesson learned from this project, anyone attempting to duplicate and build upon the project should design questions that are much easier to answer and analyze. The questions should have a clear single right or wrong answer, or be multiple choice, or be numerical. The range of answers was interesting and the answers definitely improved by the end of the 75 minute lectures, but a clear statistical analysis was not within the PI's skill set.