Standards Education in the Liberal Arts: Curricular Materials and Educational Strategies
by Paul B. Thompson, John V. Stone and Lawrence M. Busch

Introduction
In the spring of 2012, the National Institute of Standards and Technology (NIST) announced a Federal Funding Opportunity (FFO) for Education Challenge Grants administered through its Standards Services Group. The Education Challenge Grants Program provided support to projects designed to strengthen education and learning about standards and standardization and support the integration of standards education into undergraduate and graduate course curricula. The overarching goal of this program was to educate students about the impact and nature of standards and standardization so that they enter the workforce or continue their academic studies with a strong understanding and appreciation for the value and benefits of standards and standardization. A secondary goal of the program was to identify new approaches, methods, and models that can be replicated or built-on by other educational programs.

A team of researchers from the former Center for the Study of Standards in Society (CS3) at Michigan State University (MSU) proposed to develop a concept paper and corresponding module for strategic standards education as a model for a larger and more comprehensive standards curriculum plan for developing ‘standards-literate’ citizens via liberal arts education. That larger plan was developed through meetings with other standards research collaborators, faculty, and administrators at MSU and through workshop seminars from visiting scholars with expertise on various aspects of technical standards, standards development, and standards education. The present article derives from and builds upon the final report of the CS3 standards education challenge grant, and it presents ‘next steps’ to be pursued through subsequent standards education work by the project team through new collaborations with colleagues at MSU and beyond.

Project Description
Our project, titled Toward Standards-Literate Citizens: Curricular Materials and Educational Strategies, focused on educational programming, primarily at the undergraduate level, that would enhance general awareness of the role that technical standards play in contemporary life and prepare students for business, professional, political, and home environments that would be increasingly structured and affected by technical standards. Our goal was not to promote understanding of particular standards or of standardization processes at work in any specific technical domain. Rather, our concept was to identify a general knowledge of standards and standardization that could be viewed as instrumental for citizenship and full, informed participation in the technically dense civilizations of the 21st century. To this end, our initiative was dedicated to learning objectives centering on student understanding of how standards are developed and administered, and the role of social, economic, and political power in the process of standardization.

The project had three main objectives: 1) to develop and conduct a series of interviews with MSU administrators and faculty to determine opportunities for inserting courses or course modules focused on our key learning objectives into the undergraduate curriculum; 2) to develop and test modules developed with “standards literacy” in mind; and 3) to conduct a project workshop that would disseminate our findings and provide an opportunity for interested faculty to present and discuss their own ideas on standards education. The following sections describe our project activities and summarize our findings with respect to each of these three objectives.

Interviews
The three Principal Investigators (PIs) developed a plan for soliciting input from academic program administrators at MSU. Contact was made with each college indicating our project objectives. We prioritized colleges with major undergraduate programs in liberal arts. Due to time constraints for the project, it was not possible to schedule interviews with administrators from all eighteen colleges. Our principle for selecting interviews was simply scheduling availability. Interviews were conducted with deans or associate deans at the following MSU colleges:
- Agriculture and Natural Resources
- Arts and Letters
- Engineering
- Law
- Natural Sciences
- Nursing
- Social Science

The interview protocol began with a brief project statement, including a summary of the growing importance and prevalence of technical standards and our concept of citizen literacy in standards. Second, we solicited information on what is currently being done with respect to standards education in courses being taught in each respective college. We also asked each administrator whether there were any faculty in his/her college with a particular interest or expertise in standards. This stage of the interview was followed by an inquiry into administrators’ view of the relevance or importance of what we were calling “liberal arts education” in standards for their respective students, as well as their opinion on how such an objective might best be achieved. In every case, these open ended questions were covered during interviews, but the interview process was conducted so that interviewees were able to raise questions or issues of their own, and in every case the interview drifted toward subjects of particular interest to the interviewee.

As noted below, one key finding in interviews was related to integrative studies at MSU. Michigan State University has a virtually unique requirement that undergraduates must take two courses in each of three integrative studies programs: Integrative Studies in the Natural Sciences (INS), Integrative Studies in the Social Sciences (ISS) and Integrative Studies in the Arts and Humanities (IAH), or a total of six courses in all. There was a strong consensus among
college administrators that these courses would be not only the best place to address standards education, but would in fact be the only place within technical curricula at MSU where there would be any opportunity to include novel educational objectives for undergraduates that were not specifically directed toward particular technical skills or subject matter. Given this finding, we added two additional interviews to our schedule, one with the lead coordinator for integrative studies and a second with all three directors of the integrative studies centers. These interviews were structured much as those with the academic deans.

Findings from Interviews
The interviews with deans and associate deans produced a very diverse pattern of results that provokes more questions than it answers. In some cases, our respondents stated that they had never had more than a vague awareness of technical standards and were unaware of any relevance that they might have for undergraduate education. In every such case, these respondents did take deeper interest in standards as the interview progressed. Others knew immediately what we were talking about, but confessed that little was done within their curricula to provide a more general “citizenship literacy” of standards and standard-setting processes. Some indicated that specific courses would include extensive discussion of standards pertinent to the subject matter or skills being taught. The College of Engineering was a surprising exception in that the three administrators interviewed agreed that students were given almost no instruction on standards in the curricula, mainly because the specific standards relevant to engineering are in such a state of constant change and revision that there would be little point in including them.

In at least two separate interviews, administrators seemed unable to get beyond the thought of educational standards that would be used to evaluate curricula and instruction, though such standards were not a focus of our initial statement or communication. In these interviews we seemed unable to communicate the fact that our interest lay in the general role that standards and standard setting processes were increasingly coming to play in all walks of life. Although generalization from this limited set of encounters would not be warranted, it appeared that these individuals were themselves so unfamiliar with the processes of standardization that they simply could not abstract from specific standards that they were actively dealing with in their capacity as administrators of educational programs. The idea that a lack of “standards literacy” would be a problem within the faculty itself was reinforced by the Dean of the College of Natural Science, who (while endorsing the importance of our project) speculated that less than five percent of his faculty would have any idea what we meant by standards. Thus one important finding of our interviews was simply that standards education for faculty themselves would be a necessary task for bringing about any systematic effort at curricular development for standards education.

Low faculty standards literacy should not be interpreted as a lack of support for liberal arts standards education. Rather, the problem simply reflects the key premise behind our approach. The relative “invisibility” of a well-functioning standard means current generations — including most university faculty — simply do not think about how crucial standards are to modern society, much less how they came to be or the social infrastructure required for their implementation. A citizen of the future should have some awareness of these features in industrial society, but implementation of liberal arts standards education will require identifying a few “high value targets”: individuals and courses that can have significant impact, even while the majority of college faculty remain blissfully ignorant of standards literacy.

Another general finding was that MSU’s integrative studies program represents an important opportunity for moving standards education forward. This suggestion was brought up spontaneously in several interviews, and all of the administrators we spoke with (or at least those who seemed to have a clear understanding of what we talking about) endorsed integrative studies as an ideal target for a standards education initiative. As noted, we scheduled follow up interviews with integrative studies directors. Findings from these two sessions support what has been said already. Directors of MSU integrative studies centers agreed that the work on standards would be well suited to INS, ISS, and IAH courses, and added the further idea that a standards focus would be useful for their own objective of enhancing the integration across natural science, social science and arts & humanities disciplines. The main barrier would simply be the lack of standards literacy among the MSU faculty teaching integrative studies. Further interactions with integrative studies programs provide the most promising avenue for further development of the PIs’ standards initiatives.

Standards Teaching Modules
As specified in the original proposal, the project included development of standards “modules” that could be used in undergraduate courses. In preparation for developing modules, the team surveyed existing materials, including educational modules on standards and standards-setting processes that are available through ANSI’s portal to online standards and conformity assessment education ‘StandardsLearn.org’ and ISO’s ‘Education About Standards’ online resources. Our assessment of existing materials is that while they might be appropriate for individuals who have been charged with a standards related activity for a company or technical project, they neither communicate much about the extent and growing role of standards as coordinating and governance mechanisms across a wide variety of social domains, nor do they provide much insight into the power, politics and strategic aspect of standards and standard-setting. As such, we deemed these inappropriate for the purposes of a liberal arts model.

We developed two tracks for standards modules. The first consisted of a few simple classroom exercises that might be used in a wide variety of undergraduate classrooms for the primary purpose of raising students’ awareness of the scope and role of technical standards in daily life. The second consisted of a “case study” of standards and standard-setting in animal welfare for livestock production systems. In the former, Busch developed an in-class module addressing The Hidden Roles of Standards designed to illustrate how various technical, moral, social, economic, and political aspects of standards relate to each and shape our world. He tested this module in his fall 2012 Sociology course titled Science, Technology and Society. Specifically, two exercises were developed to sensitize the students to standards of measurement and to technical standards respectively. The class was divided into groups of

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three for each. The first focused on measurement. Students were asked to develop a measure using available materials and to measure the width of the classroom. Discussion followed as to how their measures were similar to and different from widely accepted measures of length. The second exercise consisted of asking students to make a list of everything in the room that was standardized and to write their list on the blackboard. They were also instructed not to duplicate things that other groups had already noted. They managed to fill blackboards on three sides of the room. A discussion followed about what it means to live in a world in which most everyday objects are standardized.

Thompson developed a unit on animal welfare standards that he tested in a fall 2013 IAH course titled Technology, Self and Society. The case was set up by introducing students to contemporary animal production methods (recall that the class draws randomly from all undergraduate majors). Students toured MSU animal research facilities that have been designed for research on pork and egg production, and which are scaled down versions of actual production methods. Through readings and discussion, students were introduced to the way that existing methods were the target of criticism and projected regulatory reform based on animal welfare. This material included an overview of several standards being utilized on food items, including organic and fair trade standards. Students were then given an introduction to the concept of standards that would be developed around various indicators of welfare, on the one hand, and facility design criteria, on the other. Both lecture and readings stressed the basic structure of a standards development process, including standard-setting and certification by third party organizations.

The success of Thompson’s module has been and will continue to be evaluated through three processes. First, examination questions (both quantitative multiple choice and open-ended essay) were structured to assess student knowledge. Second, a pre- and post-module questionnaire was administered to assess student learning. Finally, a course evaluation form was developed which included a specific question on the animal welfare standards module. These examinations and course evaluations provided some basis for determining whether the learning objective of greater standards literacy was achieved. In general, it is fair to conclude that while students were quite interested in the question of animal welfare and were able to articulate problems, they did not demonstrate a high level of knowledge with respect to standards as an appropriate or effective response to the problems that they had identified. To the extent that student writing and evaluation responses addressed standards, they expressed skepticism about the validity of all food-related standards. This result may or may not have been an appropriate judgment on current animal welfare standards, and it may reflect prejudices about food-related standards in general. Nevertheless, it suggests an equivocal result in terms of the module’s educational effectiveness in cultivating standards literacy.

**Project Workshop**

The final component of the project was a workshop to discuss “standards literacy” and to showcase cross-cutting cases for standards education in liberal arts courses. Keynote presentations were given by Christine Ervin, former President of the US Green Building Council, who spoke on the development and prospects of LEED standards, and Carl Cargill, principal for standards at Adobe, who spoke on privacy issues associated with information technology standards. In addition, the workshop included an overview of the project and presentations from other participants dealing with ongoing standards development activity with respect to animal welfare, ecosystem services, nanotechnology, and submersible vehicles. Participants in the workshop gave highly favorable evaluations of the sessions they participated in, and all agreed that standards would be a very useful platform for a variety of undergraduate educational activities. The workshop was not successful in attracting faculty or students who were not already part of the three PI’s networks, however. This result provides additional support for a key observation drawn from our interviews: lack of standards awareness, even among faculty, is one of the key barriers to implementation of standards education for the liberal arts.

**Key Recommendations, Learning Objectives, and Future Directions**

Project co-PI Stone presented the Standards Education in the Liberal Arts project goals, methods, key findings and recommendations at NIST’s Standards Education Principal Investigators’ meeting convened in November 2013 on the NIST campus in Gaithersburg, Maryland. Comments received from fellow NIST project members and NIST program officers and staff further informed our identification of next steps toward an Integrative Studies approach to standards education in the liberal arts. Central among these were 1) identifying and networking with additional MSU programs with high potential for standards education participation and programming, 2) developing evaluation metrics essential to measuring and documenting standards learning, and 3) leveraging our success in these areas in pursuit of continued institutional support and further refinement of the liberal arts model for standards education.

**Learning Objectives for Standards Literacy in General Education at MSU**

The next phase of our program is presently in development and involves creating and testing course modules for standards education in general education courses required for undergraduates at MSU. The project approach builds upon more than a decade of research conducted by Busch, Thompson, and Stone in connection with the Center for the Study of Standards in Society (CS3) at MSU. This work has been adapted to the standards educational approach that emphasizes general standards literacy, as described in this article. It emphasizes the way that science, technology, engineering, and mathematics are implicated in the development of standards that range from manufacturing and process control to regulation and program evaluation, while also stressing the way that standards development, implementation, and compliance are shaped by contingent factors of the social context. These include both formal and informal governance institutions, market structure, embedded values, and the existing distribution of wealth and political influence. We refer to our approach as “liberal arts standards education,” to emphasize its relevance to all college graduates, irrespective of their academic major or their projected career and future work life.

All PIs have defined broad learning objectives for liberal arts standards education that reflect knowledge and competency that we expect to be useful in a variety of decision-making contexts, particularly in the development and evaluation of technologies, structures, and processes that have implications for public policy. Specifically, we expect that students will learn to:

1. **Analyze standards using a systems approach:** Students will be able to apply knowledge of standards to a wide range of problems and to use standards-based decision-making processes to approach challenges.
2. **Develop and implement standards initiatives:** Students will be able to develop and implement standards initiatives to address complex problems.
3. **Communicate effectively about standards:** Students will be able to develop written and oral communications that reflect standards-based thinking.
4. **Collaborate with others in standards development:** Students will be able to work effectively in a team to develop and implement standards.
5. **Evaluate the impact of standards:** Students will be able to evaluate the impact of standards on society and the environment.
6. **Understand the role of standards in society:** Students will be able to understand the role of standards in society and the economy.
7. **Use standards as a tool for problem-solving:** Students will be able to use standards as a tool for problem-solving in a variety of contexts.

In pursuit of these goals, we propose to develop a comprehensive standards literacy curriculum that is integrated into existing liberal arts courses.
making settings ranging from professional activity directly associated with standards development to ordinary choices about consumer products such as “fair trade” products or technical devices such as smart phones. Our learning goals are also designed to allow full participation in social, political and technological life in industrial societies of the 21st century. They reflect the need for an awareness and appreciation of technical standards’ pervasiveness and significance in both technical infrastructure and social processes.

Our present efforts aim to create educational materials that will enable students to:

• Explain what a technical standard is.
• Explain how standards are developed based on a combination of science, technologies, cultural values, societal history, economic interests, and political lobbying.
• Explain the organizational means by which standards are created, implemented and regulated in governmental, nongovernmental, and commercial settings.
• Explain and predict the implications (national, corporate, strategic, economic, social, political, environmental, legal, etc.) of implementation of particular standards versus other competing standards.

Future Directions for Standards Education in the Liberal Arts

The work we are now pursuing includes two specific targets for curriculum development: 1) two of the largest ISB and ISP lab courses at MSU; 2) IAH 206 Technology, Self and Society, a course taught primarily by faculty in MSU’s Department of Philosophy. In contrast to our previous exploratory project, our present efforts will be institutional in magnitude in numerous respects. First, the educational modules that will be produced are aligned with two major MSU initiatives, the Global Water Initiative and the Food Safety Initiative, both of which are designed to coordinate activities across all three integrative studies domains. Second, it is aligned with defined MSU Undergraduate Learning Goals in Analytical Thinking and Effective Citizenship. Outputs from the project can thus be accurately represented as contributing to broad institutional objectives in undergraduate education. Third, it will have a broad impact, reaching approximately fifty percent of the undergraduate student body at MSU through the general education curricula delivered by the Center for Integrative Studies in General Science, plus a smaller percentage of students enrolled in courses delivered by the Center for Integrative Studies in the Arts and Humanities. The curricular materials developed by the project team will be delivered largely by graduate students from a wide variety of STEM related fields in the Colleges of Natural Science and the College of Agriculture and Natural Resources. There will thus be additional multiplier effects from the project. And lastly, an embedded element of the existing structure of Integrative Studies Programs is an assessment team, charged with the collection and analysis of data associated with assessment of the learning objectives described above. Longitudinal assessments will place us in a position to evaluate the effectiveness of our curricular materials and educational strategies in achieving our institutional goals associated with analytic thinking and effective ‘standards citizenship.’

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