Final Report to the National Institute for Standards and Technology

Michigan State University

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Paul Thompson, Lawrence Busch and John Stone have completed work on the NIST funded project "Toward Standards-Literate Citizens: Curricular Materials and Educational Strategies."The project was 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 of 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. This report describes project activities and summarizes our findings with respect to each of these three objectives.

Project Staffing: The first phase of the project was focused on hiring a graduate student worker and finalizing methodology. Kyle Clothier, an MS student in the Community Sustainability program was hired in October 2012. Mr. Clothier assisted project leaders with scheduling interviews (discussed below) and with collecting and summarizing data from interviews. Mr. Clothier left the project in May of 2013. Mr. Ian Werkheiser was retained for the later stages of the project beginning in August of 2013 through the project completion date on Sept. 30, 2013. Mr. Werkheiser's role was to help with logistics, organization and general activity for the September 2013 workshop.

Interviews: The three PI's developed a plan for soliciting input from academic program administrators at Michigan State University. Contact was made to 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 18 colleges. Our principle for selecting interviewees was simply scheduling availability. Interviews were conducted with deans or associate deans at the following MSU colleges:

1. Agriculture and Natural Resources
2. Arts and Letters

3. Engineering
4. Law
5. Natural Sciences
6. Nursing
7. Social Science

The interview protocol was to begin with a brief statement project 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 their college. We also asked if there were any faculty in the college with a particular interest or expertise in standards. This stage of the interview was followed by an inquiry into their view of the relevance or importance of what we were calling "liberal arts education" in standards for their students and 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 the programs in integrative studies at MSU. MSU has a virtually unique requirement that undergraduates must take two courses in each of three integrative studies programs: Integrative Studies in the Natural Sciences (offering courses with physical (ISP) and biological (ISB) science emphases), 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 specific technical skills or subject matter. Given this finding, we added two additional interviews to our schedule, one with the lead coordinator for integrative studies in the natural sciences 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. At the same time, Engineering administrators were all of a mind that the Engineering curriculum was so overloaded already that there was no room in it for a separate

course or module on standards. However, they embraced the idea of incorporating it into Integrative Studies.

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 the specific standards with which they were actively dealing 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 James Kirkpatrick, Dean 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 general finding of our interviews was simply that educating the faculty themselves would be a necessary task for bringing about any systematic effort at standards education.

The other 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 the standards setting process that are available through ANSI. We were also contacted by Ashley DeGiacomo of IP-Shield, a company that has designed a set of on-line video courses that can be used to provide training on standards formation and use. She graciously allowed us free access to her company's on-line materials. Busch reviewed each of them carefully and offered Ms. DeGiacomo the following frank critical comments: The courses were easy to navigate and well-designed from a technical perspective. However, The courses were designed in such a manner as to emphasize 'the facts' about standards, but they failed to capture the negotiation, debate, and strategic interactions that take place in standards making. They also somewhat misleadingly assumed that standards always benefit everyone. Yet, even something as simple as the adoption of standard screw threads a century ago, put a greater burden on those companies manufacturing what would henceforth be non-standard screws.

They had to re-tool their equipment, while those whose screws matched the standard did not. Finally, little or nothing was said about the very effective use of standards as industrial policy, as was the case for Japan starting in the 1960s and is the case for China today. Of course, none of this should be seen as an attempt to disparage her company's efforts, but rather to emphasize their limitations for use in an undergraduate curriculum. Indeed, our assessment of these and other 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 aspects 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 is 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 is a "case study" of standards and standard setting in animal welfare for livestock production systems.

Busch developed some in-class exercises to illustrate the ubiquity and importance of standards. Both involve a set of preliminary readings followed by dividing the class into groups of 3-4 students. The first exercise involves asking the students to create a list of all the things in the classroom that are standardized. They need not know what the technical details of the standards might be, only that the standards must exist. As they complete that task, each group is asked to post their answers on the blackboard. However, they are also asked not to post anything already noted by other groups. The students identify literally hundreds of standardized objects, but (not surprisingly) never produce a complete list. A discussion ensues as to the benefits and problems caused by the ubiquity of standards. This is followed by asking the same groups to pick one or two standards and describe (1) what assumptions are made about the persons/things for whom the standard is made, (2) what the standard enables one to do, (3) what (positive or negative consequences) might happen to those persons/things who do not meet the assumptions built into the standard, and (4) how problems might be resolved. Each group then reports back to the class for further discussion of the complex technical, ethical, social, economic and strategic issues involved.

The second classroom activity focuses on measurement. In small groups students are asked to develop their own measures of the width of the room and then to proceed to use that measure to actually measure the room. In addition to provoking a great deal of laughter, the exercise and the discussion following it allows discussion of among other things (1) the arbitrariness of most measures, (2) the varying importance of precision, depending on the situation, (3) the importance of having agreed-upon measures for both communicating and constructing things, and (4) the degree to which all technical and scientific activity is and must be based on standard measures. (In one instance, a group measured the room as 5.5 Kevins wide, where Kevin was the name of one of the students in the group; this allowed discussion of the importance of human dimensions in early measurement (e.g., feet).While not the sole purpose of the course, these exercises proved very valuable to students in a course on 'Science, Technology and Society.' As other issues were discussed during the semester, students returned questions of metrics and standards. Moreover, as many of the students in the class were majoring in the

natural sciences, they began to apply their understanding of standards and metrics to what they were learning in those classes.

Thompson developed a unit on animal welfare standards that he tested in a Fall 2013 Integrative Studies in the Arts and Humanities entitled "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 the 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. While data from the questionnaires is still being analyzed, the examinations and course evaluations provide 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 prejudgments about food-related standards in general. Nevertheless, it suggests an equivocal result in terms of the module's educational effectiveness in cultivating standards literacy.

The 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. The workshop was held September 24 and 25, with keynote presentations by Christine Ervin, former President of the U.S. 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 PIs' 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.