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Final Project Report
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Standards are Everywhere: an Information Literacy Approach to Standards Education

Project website: http://guides.lib.purdue.edu/NIST_standards

Project Description and Importance

The *Standards are Everywhere* project is an open-access, introductory-level, interactive online standards education program. The program emphasizes information literacy through students' ability to locate, understand, and apply technical standards in the context of everyday objects to make standards learning accessible and engaging. It also supports ABET Engineering Accreditation Commision (EAC) and Engineering Technology Accreditation Commission (ETAC) criteria. The program fills a gap in standards learning educational materials in that it:

- is freely available (many online standards education courses and materials are not free);
- is non-SDO specific (many existing resources that are generally targeted toward undergraduate students are provided by specific SDO's and heavily utilize standards from their organizations as examples, which can confusing for students who need to seek out standards from multiple SDO's for their multifaceted work, such as senior design projects); and
- broadly addresses standards information literacy (e.g,. searching for, identifying, and locating the full text of standards needed).

Project Goals

The goal of this project was to develop a freely available, open educational resource (OER) for standards learning focused on understanding, locating, analyzing, and applying standards as an information source in the context of engineering and technology product design, complete with transferable micro-credentialing of standards learning. The intention was to focus the content towards second-year undergraduate students in engineering technology, but it may be appropriate for use with other audiences with no prior standards background, such as upper-level undergraduates, K-12 students, and new industry professionals. Table 1 describes the student learning outcomes of the program.

Table 1: *Standards are Everywhere* Student Learning Outcomes

After completing the OER, students will be able to:
1. Describe the purpose, structure, and process of creating technical standards
2. Identify Standards Development Organizations who create standards commonly used by product designers
3. Determine what kinds of standards might apply to an artifact, either as a whole, or specific components of the object
4. Develop appropriate vocabulary (keywords and synonyms) to search for standards
5. Determine appropriate databases and web sites to discover topic-appropriate standards
6. Utilize effective strategies to refine searches for appropriate standards
7. Select two standards that relate to the design, manufacture, or testing of an everyday object (either to the object as a whole, or to a component of the object)
8. Locate and access the full-text versions of identified standards
9. Analyze and articulate the role of standards in the functioning or structure of an everyday object

Project Outcomes

The outcomes of the project, described in detail below, include the development of interactive standards tutorial modules, a standards case study database, ten student produced standards cases, and two standards badges/microcredentials.

Tutorial Modules

Four web-based, interactive tutorials, as well as a short introductory video, were developed to introduce students to the topic of standards, searching for standards, and accessing full text documents. The tutorials were developed using Articulate Storyline 2 software. Best practices of instructional design were utilized, such as incorporating activity throughout the tutorials (e.g., quiz questions and exercises that require responses), using a mix of content delivery modes to appeal to a wide array of learners (e.g., animation, video, text), and chunking content into short modules to hold students' attention and allow them to easily review

segments as needed. Closed captioning was integrated to increase accessibility. Figure 1 provides the titles and descriptions of the modules.

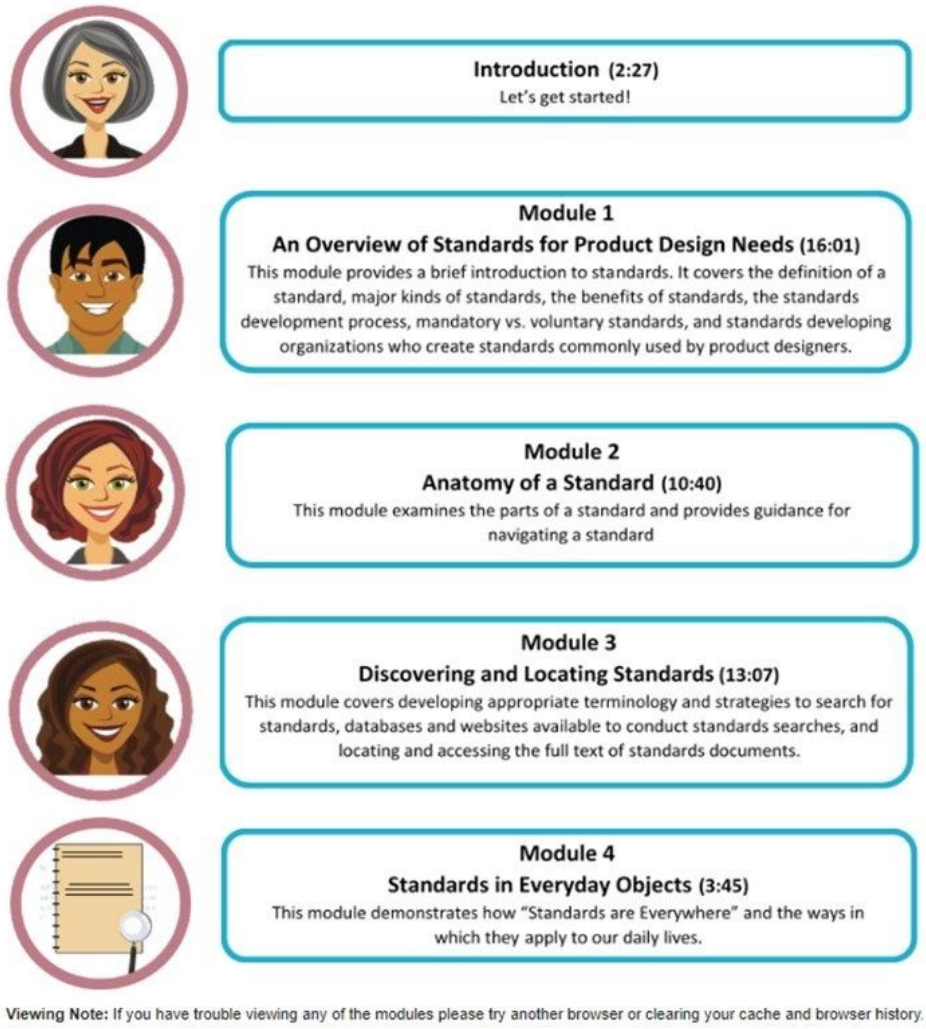

Figure 1: Titles and descriptions of *Standards are Everywhere* modules

Case Study Database and Case Studies

A community database of student-produced written and video case studies relating standards to everyday objects was developed. The database serves as a resource for instructors to demonstrate and discuss how standards apply to everyday items. The videos aid student learning by illustrating standards in action and providing real world connections. Additionally, students who upload case studies to the database can share them with prospective employers.

The database has initially been populated with ten case studies developed by undergraduate students who have taken MET 10200 (Production Design and Specifications), a course that Prof. McPherson teaches in the Purdue Polytechnic Institute that currently integrates standards education into the curriculum. Prof. McPherson worked with two undergraduate students who had experience with database programming, and campus IT, to develop a professional database (see Figure 2) that is housed on Purdue University servers. Key features of this database are the ability to search/navigate the case studies based on standards development organizations, keyword searches, the title and identification number, and by category. Additional contributions to the database are made as Purdue students complete case study assignments and are invited to voluntarily submit their work to be considered for inclusion in the community resource.

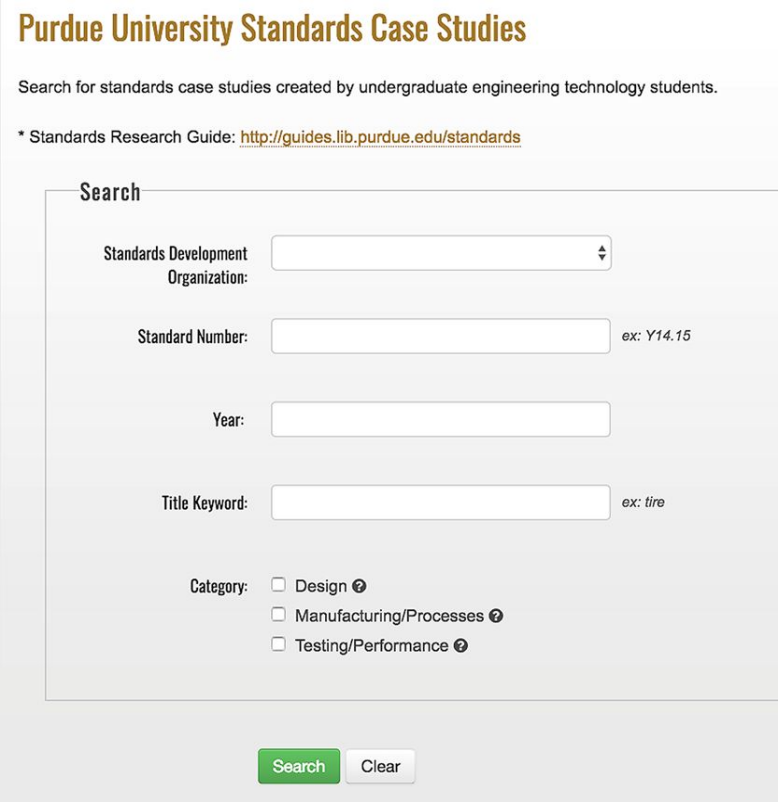

Figure 2: Screenshot of the Purdue University Standards Case Studies database

Badges/Microcredentials

We implemented two badges, Standards Explorer and Standards Integrator (see Figure 3), to acknowledge/certify foundational and proficient level competence understanding and working with standards. The badges were developed using Purdue's Passport badging platform and can be displayed on platforms like LinkedIn (see Figure 4) to demonstrate standards competence

to potential employers. The Explorer badge focused on basic knowledge and skills locating standards and understanding what standards are and how they are developed.

Figure 3: Images of *Standards are Everywhere* Explorer and Integrator badges

Explorer Badge

The specific tasks and outcomes for the Explorer badge are:

1) Locate and access two standards related to an everyday object, like a USB drive, a credit card, or a screwdriver.

   Submit a search log for the standards you located. The log should include a list of the search terms you used, what database/search engine(s), and how you revised your search to narrow your results. You should also include a brief summary of how you selected the standards you used for your final project from your search results.

2) Using the two standards from your first challenge, demonstrate your understanding of technical standards by composing and uploading a document that includes the following information about each standard:
   - Complete and correct citations for the standard
   - Correct classification of the standard as design, performance, and/or testing
   - Brief summary of the information in the standard relevant to the chosen object (i.e., how would you apply the standard to the manufacturing or use of the object)
   - Proper identification of the SDO (Standards Developing Organization) who created the standard
   - Brief background information on the SDO that describes the purpose of the SDO and its importance to the industry that created the object you chose

This badge was deployed in Prof. McPherson's MET 10200 class in fall 2018. For the course, students had to find standards related to two everyday objects. The badge provided an opportunity for students to show additional competence beyond the course, mostly by reflecting on their activities and showing a deeper understanding of the standards processes and uses. Since this time, 79 students have submitted materials to earn a badge and 25 badges have been awarded.

Integrator Badge

The evidence students provide to earn the Integrator Badge consists of a culminating report on an everyday object.

The requirement for earning the badge calls for students to:

1) Select a commonplace item such as a stove, microwave, automobile, etc. that you interact with regularly and identify how standards impact the design, manufacturing, or testing of this item.
    - Upon researching and locating some of the technical standards associated with this item, select one and develop an in-depth written case study that highlights how the technical content within this standard drives the design, manufacturing, or testing process.
    - If you cover more than one area (i.e. you write about design and testing) you should use section headers to separate the areas being analyzed.
    - Utilize images of the item to help clarify your analysis.
    - When selecting sources, work to find high quality, primary sources whenever possible, and ensure that you cite your sources appropriately.
        - Consider utilizing websites from professional organizations rather than for-profit advertising and vendor websites unless there are no other options for the material,
        - Use ebooks and articles from the Libraries collections whenever possible.
        - For images, you should work to develop your own original images rather than pulling them from a source.
    - Utilize APA formatting for all citations (images, graphs/charts, and direct quotes).
    - The analysis should be 2-3 pages in length, with a deep dive into the technical content.

An important component of the open badging initiative is to provide not only the certification of achievement, but the opportunity to supply evidence of that achievement within the badging infrastructure. Thus the challenges that students carry out are given with that in mind...the student produces a document that can be shared along with the credential itself. For example, the case study for the Integrator badge requires students to synthesize information from a variety of sources, showing that they have high-level critical thinking and

information literacy skills, demonstrating mastery of the subject content, not to mention students' written communication skills. It is much more useful to a potential employer to have a detailed document showing what the student has done, rather than something like a simple grade or acknowledgement of passing a multiple choice test.

Figure 4: Example LinkedIn integration of the Technical Standards Explorer badge.

Project Dissemination

The investigators disseminated and promoted the outcomes of this project through workshops, publications, and presentations. In total, **79 individuals from 35 institutions/organizations** attended the workshops and interacted with the standards education materials under the guidance of the investigators. The workshop materials are openly available on the project website: http://guides.lib.purdue.edu/NIST_standards. Additionally, all of the publications are openly available at the links provided below.

Workshops

- Phillips, M., Fosmire, M., & McPherson, P. (2018). Industry standards for everyone: Demystifying technical standards. *Workshop presented at the 2018 Special Libraries Association (SLA) Annual Conference*, Baltimore, MD. https://docs.lib.purdue.edu/lib_fspres/128/

- Phillips, M., Fosmire, M., & McPherson, P. (2017). Integrating technical standards into design courses. *Workshop presented at the 2017 American Society for*

Engineering Education (ASEE) Annual Conference and Exposition, Columbus, OH. https://docs.lib.purdue.edu/lib_fspres/155/.

- Phillips, M., Fosmire, M., & McPherson, P. (2017). Integrating standards into your curriculum. *Workshop presented at Purdue University,* West Lafayette, IN.

Publications & Presentations

- Phillips, M. (2019). Standards collections: Considerations for the future. *Collection Management, 44*(2-4), pp 334-347. https://doi.org/10.1080/01462679.2018.1562396

- Phillips, M., Fosmire, M., & McPherson, P. (2019). Standards are everywhere: an information literacy approach to standards education. *Presentation delivered at the ANSI/NIST Symposium: Fostering Partnerships to Integrate Standards into College Curricula in the U.S.*, Washington, DC.

- McPherson, P., & Phillips, M., & Reiter, K. (2019). Integrating technical standards into ET curricula to meet ABET standards and industry needs. *Paper presented at the 2019 American Society for Engineering Education (ASEE) Conference for Industry and Education Collaboration (CIEC)*, New Orleans, LA. https://peer.asee.org/31507

- Phillips, M., Fosmire, M., & McPherson, P. (2018). Standards are everywhere: A freely available Introductory online educational program on standardization for product Development. S*tandards Engineering*, 70(3), 1-6. https://docs.lib.purdue.edu/lib_fsdocs/201/

Additionally, IEEE profiled our project on their IEEE Standards University platform.

Project Evaluation

Project Website Metrics

The project website (http://guides.lib.purdue.edu/NIST_standards), the gateway to the standards educational materials, was launched in June 2017. In order to promote wide use, we made the decision to allow the project website to be openly accessible without any registration requirement. As of 2/14/2020, the project website has **4,286 views**.

Integration by Purdue University

To date, the materials have been used **by at least 751 undergraduate students** at Purdue University. It is known the tutorial modules are integrated into these courses:

- MET 10200 Production Design and Specifications - since the Fall 2017 term, **684 mechanical engineering technology (MET) students** have completed the *Standards are Everywhere* tutorial modules in this course. Prof. McPherson and Prof. Phillips facilitate a flipped classroom standards education lesson where the students complete the tutorials and a standards assignment before coming to class and then go through group exercises to engage further with the standards content in the classroom. This is the start of a multi-week module on standards in this course. We will continue to integrate the educational materials into this course.

- MSE 440000 Materials Processing Design II - in the Spring 2020 term, instructors from the School of Materials Engineering (MSE) began integrating the tutorial modules into MSE 44000, the second course in the school's senior design sequence. **67 MSE students** completed the *Standards are Everywhere* modules this term. MSE plans to continue to integrate the modules into the course every year.

Integration by the University of Buffalo
An engineering librarian from the University of Buffalo, Erin Rowley, has partnered with engineering education faculty to integrate *Standards are Everywhere* modules 1 and 2 into selected sections of EAS360, a STEM technical communication course. To date, **125 University of Buffalo undergraduate students** have completed the modules.

Peer Feedback - ASEE Workshop
We conducted a workshop titled "Integrating Technical Standards into Design Courses" at the 2017 ASEE (American Society of Engineering Education) Annual Conference in June 2017 in Columbus, OH. The workshop description can be viewed at this link: http://bit.ly/2p52AbW. 34 people (STEM librarians and engineering and technology faculty members from a variety of universities and colleges) attended the workshop. The participants were asked to watch our tutorial modules and complete an online feedback form on the accuracy, relevancy, and engagement level of the modules prior to attending the event. The results of this feedback were used to improve the modules.

Usability Study
We conducted a 2.5 hour usability study with seven undergraduate engineering technology students in March 2018. This allowed us to test the functionality and performance of the modules further with our target user population. The students reported they found the content insightful and believed learning about standards will be helpful to them in their future projects and careers. They provided suggestions for improving the modules, most notably the in-module assessments. We made changes into the modules based on the results of this study.

Number of Badges Earned
To date, 79 Purdue University students submitted materials to earn the Explorer badge and 25 badges have been awarded.

Findings and Lessons Learned
We have received much positive feedback about the *Standards are Everywhere* materials from librarians (academic, corporate, and government), engineering educators, and industry professionals at our workshops, presentations, and through informal communications. We know the materials are being heavily used in required courses at Purdue University and are still continuing to be discovered and utilized by other institutions, such as the University of Buffalo. Additionally, we received a request from the Society of Standards Professionals (SES) education committee to utilize the *Standards are Everywhere* materials at their 2020 annual pre-conference workshop. Lastly, we have recently been informed by Mary Jo DiBernardo (Program Manager, Standards Coordination Office, NIST) that the Department of Homeland Security has expressed interest in our standards education materials.

One limitation to our work is that our decision to make the materials as openly available as possible (i.e. we do not require registration to access the materials) gives us limited insight into who is using the materials, and how the resources are being used. We know the project website has 4,286 views (as of 2/14/2020), but we have limited knowledge of the actual users and use cases.

Another limitation to the project relates to the development of student-produced video case studies, resulting in the database mainly consisting of written case studies. Prof. McPherson's intention was to find companies that would be willing to allow videography of standards in action to work with the students. However, he was not successful in finding companies to agree to videography. Prof. McPherson worked with one of the students who completed a written case study on the safety testing of a chest of drawers to develop a video outlining how the test would actually be conducted. In order to conduct the experiment of ASTM F2057-17 (Standard Safety Specification for Clothing Storage Units), a chest of drawers that had the proper slide rails was purchased and two steel blocks meeting the correct weight specifications were machined. The video of the test has been published to the case study database. Prof. McPherson will offer extra credit to students to produce future video cases.

Additionally, we have experienced challenges implementing the badge/micro-credentialing aspect of our project as originally conceptualized. At the onset of our project, the Purdue University Passport badging platform was openly available for anyone to use. Since this time the platform has been locked down to only Purdue users without additional payment. Also, updates to the platform have resulted in it being somewhat cumbersome for students to

complete the challenges and for instructors to evaluate the submissions. We plan to seek out an alternative platform for badges to reside on. In addition, Professor McPherson is exploring the idea of integrating the Integrator badge that requires an in-depth case study into his advanced mechanical design course, instead of MET 10200, since these advanced students are further along in the program, more experienced, and more motivated about demonstrating expertise for potential employers.