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Engineering Technology Programs and Technical Standards: Investigating Library Access and Course Integration

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Abstract

Due to ABET accreditation requirements and industry expectations, integrating technical standards into Engineering Technology (ET) curricula is crucial for student success. However, previous studies have shown that faculty report access and knowledge challenges in working to integrate standards into ET course content. Additionally, academic librarians have long acknowledged there are many issues with providing access to standards to campus users, such as high costs and extensive digital rights management (DRM) restrictions. The purpose of this study is to conduct an environmental scan of library websites at institutions with ET programs to investigate library-provided access to standards and to survey ET faculty members about their contemporary standards education approaches and practices. A key finding is that ET students at larger schools are much more likely to have access to standards online, with 82% of libraries at institutions with over 15,000 students subscribing to standards online versus only 46% of libraries at institutions under 10,000 students. Additionally, the results show there is a disconnect between library-provided access to standards (58% of libraries provide online access) and ET faculty members' use of academic libraries for standards access (28% report using standards through the library). More education about technical standards is needed for ET faculty members working to integrate standards into curricula. Standards developing organizations (SDOs) should consider investigating ways they can offer educational opportunities for faculty, provide specific case studies and examples of how standards could be implemented into various ET courses, and if they are not already doing so, offer free or low-cost solutions for faculty to obtain standards for use within a course.

1. Introduction

Technical standards provide the foundation for the design, implementation, and maintenance of safe, interoperable, and efficient products and practices. Learning about and using standards is essential for ET students, as evidenced by ABET Engineering Technology Accreditation Commission (ETAC) criterion 5 (the curriculum must "include design considerations appropriate to the discipline ... such as: industry and engineering standards and codes…") and several program criteria, such as 'Mechanical Engineering Technology and Similarly Named Programs' criterion k for bachelor's programs, which requires the "application of industry codes, specifications and standards" (ABET 2022a). Additionally, future employers expect ET graduates to have experience with standards upon hire (Harding and McPherson 2010; Phillips, Zwicky, and Lu 2020).

Several studies have reported successful integrations of standards into ET courses and programs. With funding from the National Institute of Standards and Technology (NIST), Huderson et al. developed a programmatic approach for American Society of Mechanical Engineers (ASME) standards education that is being tested in mechanical engineering and mechanical engineering technology (MET) programs at 19 institutions (Huderson et al. 2019). Additionally, Phillips & McPherson scaffolded standards into a sophomore level MET Computer Aided Design (CAD) course, focusing initially on how standards relate to the everyday objects students interact with (Phillips and McPherson 2016). Lastly, Cioc et al. used problem-based learning to teach senior level MET students about standards and codes (2020). Despite these examples and the demonstrated importance of standards, Khan, Karim, and McLain surveyed ET faculty and found that 49% reported a "lack of expertise" and 42% a "lack of access" as impediments to integrating standards into curricula (2013).

Additionally, academic librarians have long acknowledged there are many issues with providing access to standards to campus users, such as high costs and extensive DRM restrictions (Phillips 2019). Previous researchers have surveyed librarians about standards collections at their institutions, including Pellack's (2005) and Wetzel, Grove, and Flaks' (2021) investigations of libraries who are members of the Association of Research Libraries and have engineering

programs and Matthews' survey of librarians at top ranked engineering schools (2006). Matthews' study also examined library websites for details related to standards.

However, the authors are not aware of any studies that focus specifically on ET programs, or any contemporary studies that have examined library websites for information about standards access. Additionally, with Khan, Karim, and McLain's study (2013) being nearly a decade old, there is a need to explore contemporary standards education approaches and practices into ET programs. These are gaps this study intends to fill.

This study addresses two research questions: 1) What access to standards do academic libraries with ET programs provide to their users? and 2) How is standards education currently integrated into ET curricula?

2. Methods

The authors conducted an environmental scan of library websites at institutions with ET programs to evaluate library-provided standards access and support and surveyed ET faculty members about their integration of standards into ET curricula.

2.1 Data Collection and Analysis – Environmental Scan

On April 16, 2021, the authors generated a list of ETAC ABET-accredited BS programs located in the United States, limiting the query to the disciplines of Mechanical Engineering Technology and Electrical and Electronics Engineering Technology and exported the list of institutions to an Excel file. Next, a content analysis approach was used to gather information about each institution by building a data extraction form into Qualtrics. The data gathered consisted of 12 items covering details such as demographic information, library-provided discovery and access modes to standards, and library promotion of standards and standards educational materials. The data extraction form can be viewed in Appendix A. Co-author LeClerc, a graduate student, gathered the data and into Qualtrics and co-author Phillips, a librarian very familiar with academic library websites, reviewed and edited the data for accuracy. Data collection was completed between June 2021 and October 2021. Lastly, the raw Qualtrics data was exported to a .csv file and the quantitative data analysis was performed in Microsoft Excel.

2.2 Data Collection and Analysis – Faculty Survey

First, co-author McPherson, an MET faculty member, interviewed two ET faculty members at institutions outside of Purdue to learn more about how they currently integrate standards into courses they teach. The interviews were conducted over Zoom, audio-recorded, and transcribed using Scribie.com. A convenience sampling approach was used to recruit interview participants from the ET institution list derived for the environmental scan. The authors read the interview transcripts multiple times and used the results to inform the development of a survey for ET faculty members. In developing the instrument, the authors also reviewed the survey Khan, Karim, and McLain (2013) used to gather information about standards in ET curricula.

The authors created a 14-question survey in Qualtrics and distributed it twice to the American Society of Engineering Education (ASEE) Engineering Technology Division (ETD) listserv in January and February 2022. A drawing for two $50 Visa gift cards was offered as an incentive for survey completion. To analyze the results the authors exported the raw Qualtrics data to a .csv file and performed quantitative and qualitative data analysis in Microsoft Excel. Descriptive statistics were calculated for qualitative data. The authors performed inductive analysis on the qualitative data to identify the overarching themes in the open-ended participant responses. The survey instrument is available in Appendix B. The research was reviewed and approved as exempt by the university's Institutional Review Board (IRB-2021-1802).

3. Results

3.1 Environmental Scan

3.1.1 Institution Demographics and Online Standards Access

The list the authors generated from the ABET website contained 102 unique institutions, of which 87 were public and 15 private. Table 1 details the sizes (by student headcount) of the institutions in the dataset, as well as if the institutions subscribe to standards online and/or the database Compendex. The authors were interested in Compendex access since this database indexes standards from multiple standards developing organizations (Phillips 2021). "Not sure" was recorded when libraries did not make their database list openly available on their websites.

For the 59 institutions that indicate on their library websites they subscribe to standards online, the authors recorded if their access was through a standards aggregator. Generally, standards aggregators are third party providers and sell individual standards and/or online subscriptions, but they do not develop standards themselves (Phillips and Huber 2017). As shown in Figure 1, only 22 of the 59 (37%) institutions that have online access to standards indicate they subscribe to a standards aggregator. The most frequently listed aggregator was TechStreet (n=10).

Table 1. Institutions by student headcount that subscribe to standards online and/or to the database Compendex.

Institution size (by student headcount)	#	Subscribe to Standards Online (n=102)			Subscribe to Compendex (n=102)		
		Yes	No	Not Sure	Yes	No	Not Sure
5,000 or fewer	21	43%	43%	14%	14%	71%	14%
5,001-10,000	18	33%	61%	6%	33%	61%	6%
10,001-15,000	29	55%	45%	0%	28%	72%	0%
15,001-20,000	10	70%	30%	0%	70%	30%	0%
20,001-25,000	9	89%	11%	0%	33%	67%	0%
25,001 or more	15	87%	7%	7%	67%	27%	7%
Total	**102**	**58%**	**37%**	**5%**	**36%**	**59%**	**5%**

The 22 institutions that indicated on their library websites they subscribe to standards through aggregators listed a variety of SDOs and individual standards, including ICC (11), AASHTO (7), NFPA (7), ASHRAE (6), ASME (5), ASTM (4), ASCE (2), ACI (2), API (2), BOCA (2), BSI (2), ICBO (2), ISO (2), Local codes (2), SBCCI (2), State codes (2); the following were indicated one time: AATCC, AHAM, ANSI Z80-1, ANSI Z80-20, ANS, ASA, CSI, FGI Guidelines, IBC, ICAO, IEC, NSF, NSAA, SMACNA 1966 Duct Construction Standard, SAE, UBC. In six instances, libraries indicated on their website they subscribed to an aggregator but did not share which SDOs or individual standards they subscribe to via that aggregator.

Additionally, the authors reviewed which standards collections the libraries indicate they subscribe to directly through SDOs. As shown in Figure 2, the authors found that IEEE Xplore 47/102 (46%) and ASTM Compass 40/102 (39%) were the most frequent SDO platforms listed on the library websites.

3.12 Hard Copy Standards

To determine if the libraries collect physical copies of standards, the authors conducted searches in library catalogs for common standards organization acronyms, such as ANSI, ASTM, ISO, NFPA and "standard," and limited to items held by the library. The authors found that 78/102 libraries provide access to at least one hard copy standard, while 17 did not. In three cases the catalogs were not publicly searchable, so it was not possible to determine if the libraries provide hard copy access. Additionally, four libraries were found to provide a separate search tool or listing of hard copy standards for users, such as the Michigan Tech Standards Database (Michigan Tech Library n.d.)

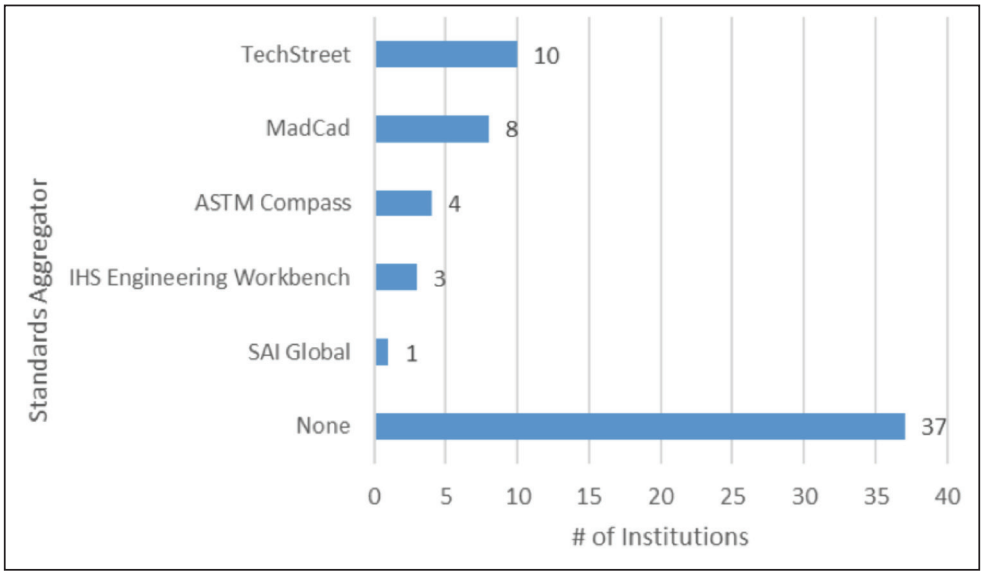

Figure 1. Standards aggregator subscriptions of the institutions (n=59) that indicate on their library website they subscribe to standards online. Three institutions' library websites indicate they subscribe to multiple standards aggregators, making the overall total n=63. ASTM Compass was only considered an aggregator if a library reported subscribing to standards other than ASTM through this platform.

3.13 Links to Free/Low-Cost Standards

The authors found that 30/102 (29%) of the library websites provided at least one free or low-cost standards resource for users. Table 2 contains a list of resources that were provided by at least two libraries.

3.14 Library Guides

Library guides are webpages created by library faculty and staff that provide links and research guidance on a particular topic, or for a specific purpose (e.g., a course, a major) (Dobbs et al. 2013). These guides help users efficiently and effectively connect to subscription library resources, as well as relevant materials that are freely available. Library guides are commonly referred to by other names, such as research guides, subject guides, course guides, or major guides. As part of the environmental scan, the authors examined library websites to determine which libraries at institutions with ET programs have created a dedicated standards library guide (e.g., https://guides.lib.k-state.edu/standards), or have a section about standards on another library guide created for a course or a major (e.g., https://libguides.lib.mtu.edu/meem3901). See Table 3 for the findings.

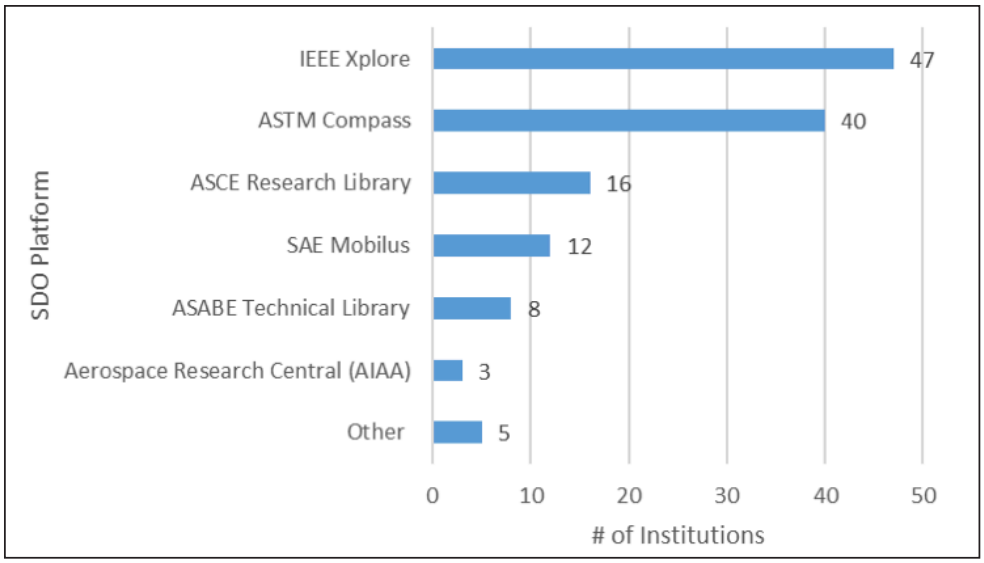

Figure 2. Standards collections provided directly via Standards Developing Organization (SDO) platforms of the institutions (n=59) that indicate on their library website they subscribe to standards online. Other (1 each): ASHRAE, AWS, API Compass, NFPA, ASME Standards Collection (BPVC only).

Table 2. Free/low-cost standards resources - listed by at least two libraries.

Resource	Link(s)
ANSI University Outreach Program	https://www.ansi.org/education/activities/standards-university-outreach
American Welding Society (AWS) (some standards noted as freely available)	https://www.aws.org/standards/page/free-downloads
Government-related standards	Defense Standardization Program ASSIST database (https://quicksearch.dla.mil/qsSearch.aspx) Occupational Safety and Health Administration (https://www.osha.gov/laws-regs)
Incorporated by Reference (IBR) Standards Hosted by ANSI	https://ibr.ansi.org/
International Telecommunications Union (ITU)	ITU-D Recs (https://www.itu.int/rec/D-REC/en) ITU R Recs (https://www.itu.int/pub/R-REC) ITU-T Recs(https://www.itu.int/en/ITU-T/publications/Pages/recs.aspx)
National Institute of Standards and Technology (NIST) Free Standards List	https://www.nist.gov/standardsgov/standards-organizations-offer-free-access-their-standards
National Fire Protection Association (NFPA) (view only)	https://www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/Free-access
National Information Standards Organization (NISO)	https://www.niso.org/publications
Underwriters Laboratories (UL) Standards (free access via "Digital View")	https://www.shopulstandards.com/Catalog.aspx

3.15 Links to Standards Educational Resources

The authors found that 26/102 (25%) of the library websites contained links to at least one standards education resource for users. Table 4 summarizes the standards education resources listed by at least two libraries.

3.2 Faculty Survey

Using the ASEE ETD listserv, the authors sent a survey aimed at investigating the current state of implementing standards into ET courses and if the faculty partnered with campus libraries. It is important to note that respondents did not have to answer all questions to partake in the survey, resulting in some number discrepancies when cross-tabulating results. Ultimately there were 54 respondents, of which 50 indicated instructing at public institutions and four at private. Faculty were asked if they currently integrate standards into their curriculum, as well as if they collaborate with the campus libraries in doing so. Table 5 provides a breakdown of the responses provided from those working at public institutions. Of the four respondents from private institutions, three indicated that standards are incorporated; however, there were no partnerships with the libraries for such integration.

When asked about the types of standards that are utilized, respondents indicated that they rely on a variety of SDOs. Figure 3 provides a graphical representation of the SDO that develops/publishes the standards most utilized by instructors, with many indicating that they utilize standards from a variety of SDOs. Additionally, the National Electrical Manufacturers Association (NEMA) and Occupational Safety and Health Administration were the most mentioned SDOs in the "Other" category. When specifying the exact standards used in the courses, the majority were from ASTM as well as the National Electrical Code. When asked where the standards are obtained, the majority of the 68 respondents suggested that they either find them for free (21/68 or 31%) or rely on their campus library (19/68 or 28%). Table 6 provides a breakdown of how instructors obtain these standards from various sources. Ironically, while many standards are

Table 3. Standards library guides by frequency.

Results	# of Libraries
Dedicated standards library guide	7
Section about standards on a major or course guide	28
Both a section about standards on a major or course guide and a dedicated standards guide	12
No dedicated standards guide nor a section about standards on a major or course guide	53
Could not determine (all library content behind a login requirement)	2
Total	**102**

Table 4. Standards education resources by frequency.

Results	# of Libraries
Library created print or video tutorials	16
ANSI StandardsLearn.org	7
ASTM Students & Professors (https://www.astm.org/studentmember/index.html) [NOTE: This site has been updated, previously it contained many educational resources for professors and librarians: https://web.archive.org/web/20210303001405/https://www.astm.org/studentmember/index.html]	5
NIST Standards.gov	3
ANSI Education & Training (https://www.ansi.org/education/standards-education-training)	2
IEEE Standards University (https://www.standardsuniversity.org/)	2

Table 5. Cross tabulation of public institution size, integration of standards, and partnership with campus librarians or libraries.

Institution Size (By student headcount)	#	Current Integration of Standards into Curriculum (n=45)		Partner with Library or Librarians to Integrate Standards (n=32)	
		Yes	No	Yes	No
5000 or fewer	9	6	2	1	4
5001-10,000	10	6	1	1	5
10,001-15,000	9	9	0	1	6
15,001-20,000	3	2	1	1	1
20,000-25,000	0	0	0	0	0
25,001+	19	12	6	4	8
Totals	**50**	**35**	**10**	**8**	**24**

able to be obtained through the campus library system, only 23% (8/35) respondents indicated partnering with campus libraries or librarians in their integration of the standards into their curriculum.

When asked if technical standards are currently integrated into courses, 79% (38 of 48) responded that they do, in fact, utilize standards as part of their curriculum and have been doing so for nearly a decade or more. The courses where standards seem to be integrated the most include senior capstone, mechanics and strength of materials, courses related to mechanical design, and electrical machines and power. Figure 4 indicates the frequencies at which respondents indicated the various types of courses with which standards are typically integrated. The top three reasons that the 10 respondents gave as to why they do not integrate standards into their courses included standards are not relevant to their courses (4), there is not enough time (4), and that they do not feel as though they have the necessary expertise for such integration (3).

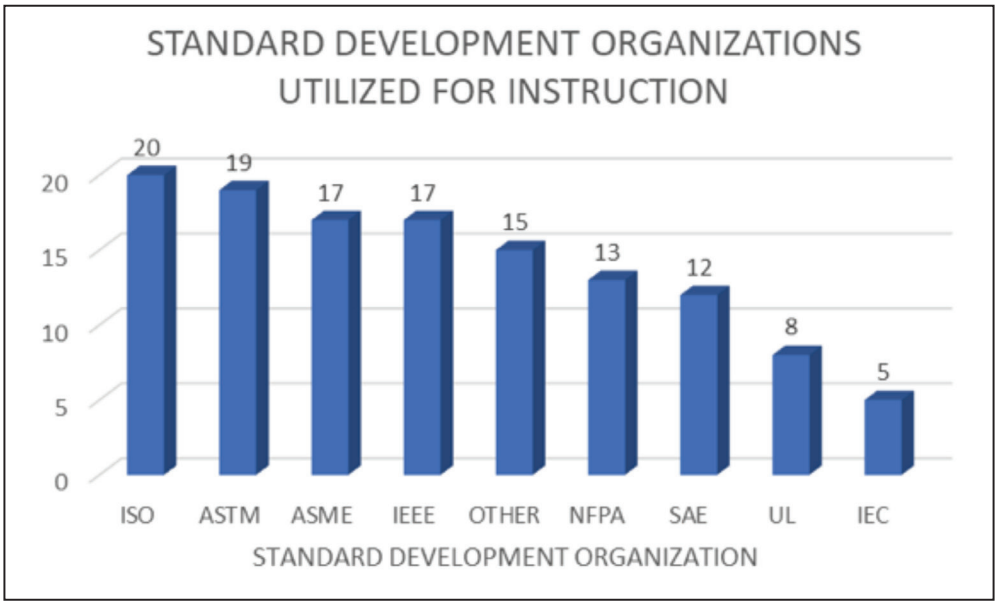

Figure 3. Frequency of use of standards from various standards development organizations.

When asked if there was interest in "becoming educated (or further educated) about technical standards," 39 of the 45 respondents indicated some level of interest; however, when describing the topics of interest, many of the answers were extremely specific to certain applications with overall themes of design, electrical, material and ISO standards. Of the 83 individuals who indicated which educational approach might be taken to learn more about standards, the overwhelming majority (52) indicated that they would prefer online and self-paced tutorials, 27 and

Table 5. Cross tabulation of public institution size, integration of standards, and partnership with campus librarians or libraries.

SDO	Campus Library	Own Funds	Depertment Funds	Professional Society Memberships	Find Friendly Available Standards Online
ASTM	11	3	6	4	11
ASME	10	3	4	6	11
IEEE	9	1	2	5	11
SAE	6	3	2	4	7
UL	3	1	3	3	5
NFPA	3	1	1	3	7
ISO	12	3	5	6	13
IEC	3	1	0	3	3
OSHA	0	0	2	1	2
NEMA	1	0	1	0	2
TOTALS	**58**	**16**	**26**	**35**	**71**

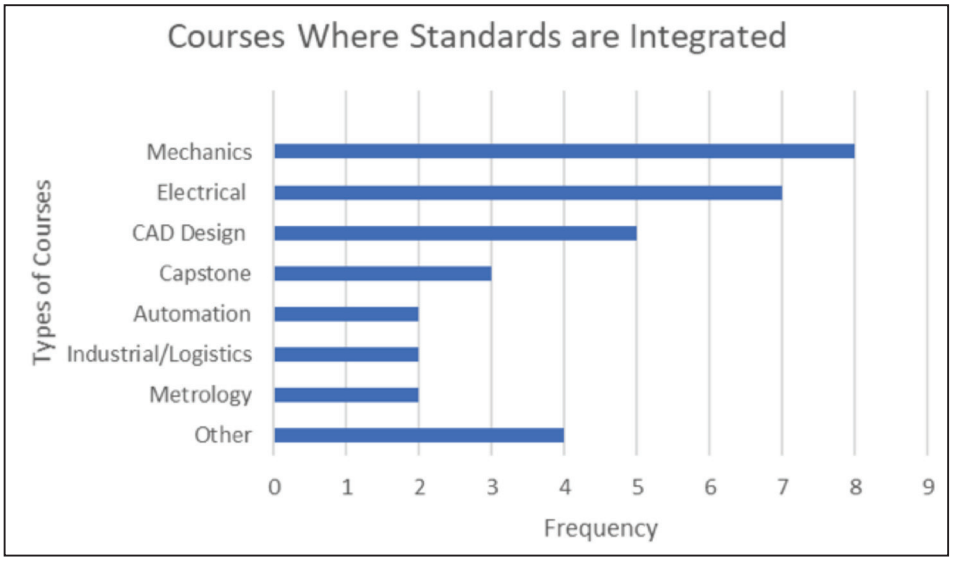

Figure 4. . Frequency of types of courses where standards are utilized.

25 respondents respectively. Additionally, 30 respondents indicated that either professional association offerings (17) such as webinars and workshops along with outside speakers for a seminar/workshop (13) would be the best format for learning more about standards.

Several participants provided their personal input about the barriers associated with getting more faculty to integrate standards into the curriculum. The most common reasons included the lack of course time to implement standards, the lack of knowledge about their importance, and the accessibility of standards due to cost. Additionally, participants were asked to provide ideas on how to promote the integration of standards, for which many suggested mandating standards be required as part of the course learning objectives and laboratory exercises. Other suggestions include more mandatory requirements from ABET, the development of an entire course solely on standards, as well as the development of free modules via social media platforms or standard development organizations' websites for students to complete.

4. Discussion

4.1 Standards Access

At institutions with ET programs, 58% of libraries (59/102) subscribe to standards online (see Table 1), with ASTM and IEEE standards being the most frequent subscriptions. The results are skewed towards larger institutions, with 82% of libraries at institutions with 15,000 or more students subscribing to standards online, whereas only 46% of libraries at institutions with 10,000 or fewer students subscribe to standards online. There are likely many reasons for the differences by institution size. Standards are known to be cost prohibitive for libraries to acquire (Phillips 2019; Pellack 2005), and larger libraries have more funding available for purchases. It is also likely that larger institutions support multiple engineering and ET programs that require standards integration to meet ABET accreditation requirements (ABET 2022a, 2022b) and support research projects that utilize standards (Rowley and Wagner 2019). Additionally, larger institutions are more likely to have dedicated engineering and technology librarians who advocate for standards access for users. At smaller institutions with fewer employees, there may only be one librarian responsible for all science- and technology-related subject areas.

Library staffing issues may also contribute to the underpromotion of standards resources to faculty and students. Less than half of the libraries in the current study have a standards guide or section about standards on the library website (see Table 3) and only 29% of the libraries promote the use of free/low-cost standards resources (see Table 2). Underpromotion of standards resources may be one reason for the lack of faculty use of library provided standards collections. In the current study, only 28% of the faculty survey respondents reported getting access to standards via the campus library.

Additionally, standards are specialized resources that are not typically part of library and information science curricula. This results in many librarians being unprepared to work with standards collections and teach about standards. Some librarian professional societies provide educational opportunities about standards, such as the ASEE Engineering Libraries Division (Phillips, Fosmire, and McPherson 2017; ASEE Engineering Libraries Division n.d.), and there is a growing body of literature for librarians focused on collecting (Phillips 2019; Van Loon 2022; Dunn and Shiyi Xie 2017) and teaching about standards resources (Phillips and McPherson 2016; Leachman and Leachman 2015; Solomon, Liao, and Chapin 2019; Cioc et al. 2020).

Table 2. Cost of vehicle components.

4.2 Standards Course Integration

The results of the faculty survey indicate that despite many resources being available at institutions with ET programs and many faculty actively integrating standards into their curriculum, there are gaps in ensuring the maximum utilization of such resources into ET curriculum. The data suggest there may be opportunities for more collaboration between faculty and librarians when attempting to obtain access to standards as 75% of respondents (24 of 32) indicated that they do not currently work with campus libraries when it comes to standards integration. Broken down further, 64% of respondents from larger institutions (15,000+) indicated not currently working with campus libraries when it was found that over 80% of the libraries at larger institutions have some access to standards readily available. For smaller institutions (less than 15,000) 83% of faculty (15 of 18) do not partner with their campus library, yet over 40% of libraries at smaller institutions do, in fact, have access to standards.

While many ET faculty find standards important enough to actively integrate them into various courses, there are still opportunities to increase both the number of faculty who utilize standards and the types of courses for which they are implemented. The faculty responses indicate that there are specific types of courses for which standards are implemented, which is ultimately a very small subset of ET curriculum, leading to the possibility of further integration into other ET courses. While faculty respondents indicate using standards from a variety of SDOs, which is excellent for student exposure, many seem to rely heavily on personal, departmental, or professional memberships to access such standards, when they may be able to capitalize on the resources available at their libraries and gain access to even more applicable standards.

Finally, while it would appear that the faculty are interested in learning more about standards and believe that the implementation of standards should be a required facet of ET curriculum, data from this research aligns with the suggestions made in 2013 by Khan, Karim, and McClain: that the reasons faculty do not integrate standards into ET curriculum continues to be lack of time, faculty knowledge and experience, and accessibility. To overcome these hurdles, a first step would require that education about standards become a mandatory part of the curriculum, which several respondents supported. This would help foster the demand for classes, seminars, and tutorials that faculty could partake in to develop the knowledge and experience with standards that could be utilized in their courses.

4.3 Course Action Plan

The authors encourage educators who are seeking ideas of how standards can be integrated into their curriculum to review Using Everyday Objects to Engage Students in Standards Education by Phillips & McPherson (2016). Readers will discover how McPherson, an MET instructor, and Phillips, an engineering librarian, engage students in learning how standards directly influence the design, manufacturing, and testing of common everyday objects. Phillips & McPherson further illustrate how standards education can be scaffolded throughout an undergraduate MET design course by utilizing a variety of technical standards throughout the mechanical design projects undertaken by students.

As educators explore ways of integrating into their curriculum, they should start at a rudimentary level, such as showing students the ASTM standards for a testing standard dog bone specimen, or the electrical standards that outline the colored bands on resistors, and why such standards are important for to understand and utilize. Educators should then consider the lab exercises that will be undertaken and how they can demonstrate the practical application of standards in undertaking the lab, which ultimately will make the process of utilizing standards common practice for students.

4.4. Limitations

4.41 Environmental Scan

In reviewing library websites, there were times it was not clear if a library subscribes to standards via a certain platform. For example, in subscribing to IEEE content, libraries have options for selecting different combinations of resources for access on IEEE Xplore (e.g., journals, conference papers, standards). For the purposes of this project, the authors did not classify a library as having access to a particular standards collection unless it was specifically stated somewhere on their library website, whether that be on their database listing page (often known as the libraries database A-Z list), or on a supporting page, such as a subject or course guide. Due to this approach, it's possible more libraries subscribe to various standards resources, but this information was not shared on their website at the time of the authors' review.

Additionally, the authors' limited their review of library websites to institutions with ABET-accredited MET and EET BS programs. While these are the largest ABET-accredited ET undergraduate programs, and while many institutions that have MET and EET programs also have other ET programs (e.g., civil), future studies should expand the population and review the library websites of all ET undergraduate programs.

Lastly, the environmental scan provides limited insights about librarian experiences with standards at institutions with ET programs. The authors are in the process of conducting a survey of librarians at institutions with ET programs to further understand librarian experiences and needs with standards.

4.42 Faculty Survey

The authors utilized convenience sampling with the ASEE ETD listserv. This listserv, while an appropriate method of reaching faculty associated with Engineering Technology curricula, by no means reaches the entire population of faculty associated with these disciplines. Additionally, it is possible that those who chose to respond to the survey are the most familiar and comfortable with the topic of industry standards.

5. Conclusion

Through this study, the authors discovered that while there seems to be an increase in institutions having access to standards, there is a noticeable disconnect when it comes to collaboration with ET faculty and course integration. Therefore, the authors highly encourage ET faculty to reach out to their campus librarians to learn more about accessibility and determine how the resources available can be better utilized. Additionally, the authors suggest that individuals working with SDOs investigate ways to increase their presence in ET programs through contacting faculty directly to seek collaboration.

The authors charge SDOs with investigating ways they can host engaging educational forums for faculty to increase their awareness and knowledge of standards, provide specific case studies and examples of how standards could be implemented into various ET courses, and how to offer free or low-cost solutions for faculty to obtain standards for use within a course, such as the SDOs highlighted in Table 2. More free/lost-cost access to standards could particularly benefit students at smaller institutions who are less likely to have access to standards than students at large institutions.

Finally, the authors encourage ET faculty to work on broadening the number of courses for which standards are integrated, as the current study suggests that students in only a handful of courses are being introduced to standards. With the plethora of online communication and learning today, the suggestions of workshops, self-paced modules, and webinars should be explored as an option by all parties associated with standards education to aid ET faculty in this endeavor.

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Appendix A

Environmental Scan Library Website Data Extraction Form

[This form was built into Qualtrics]

1) Institution name:
2) Is the institution public or private? (Public / Private / Not sure)
3) Institution size: <5000 students, 5,001-10,000 students, 10,001-15,000, 15001-20,000, 20,001-25,000, 25001+
4) Using https://carnegieclassifications.iu.edu/lookup/lookup.php, identify the Carnegie Classification of the institution.
5) List the library website:
6) Does the library subscribe to standards online? (Yes / No / Not sure)

   Tips (look for a library A-Z database list, search for "standards"; make sure you're limiting the resource/publications type to standards) (If yes, below, if no, skip A and B)

   a. Logic (6a) If yes to 6, which standards aggregator databases does the library subscribe to? (check all that apply) Choices: TechStreet, IHS Standards Explorer, IHS Engineering Workbench, ANSI Standards

continued on next page

Connect, SAI Global, MadCad, Document Center, SAI Global (Standards Infobase, or Standards Management i2i), Other (list), None, Not sure

b. Logic (6b) If 6a is not None or Not sure, What standards/collections does the library the subscribe to through their aggregator database(s) (select all that apply): ASME, ASME BPVC, ASTM, NFPA, ANS, AASHTO, ACI, AHAM, ASHRAE, ICC, NFPA, BSI, ISO, Other(s): List here

c. Logic (6b) If yes to 6, what full text vendor standards platforms does the library subscribe to? Check all that apply: Choices: IEEE Xplore, ASTM Compass, ASCE, Aerospace Research Central (AIAA), ASME, ASABE, SAE, Other(s): List here

(note: the database description MUST include mention of standards for all of these except ASTM)

7) Does the library subscribe to Engineering Village (Compendex), which indexes many standards collections? (Yes / No / Not sure)

(tip: look in the Database A-Z list for Engineering Village and Compendex)

8) Does the library provide access to standards in hard copy format (either through their library catalog or a separate search tool or both, such as: http://project.lib.mtu.edu/standards/)? (Yes, No, Unsure)

Logic: 10a If yes, choose all that apply catalog, separate search tool (and provide link); unsure

(tip: can be tricky to determine if these are in the catalog; search library catalog for common standards organizations, like ANSI standard and ISO standard, limiting to items held by the library)

9) Is there a standards library guide, such as: https://libguides.lib.mtu.edu/standards? (Yes (provide link), No , Not sure - provide notes)

10) What links are provided to free or low cost standards? Select all that apply: ANSI University Outreach Program, ASTM Standards on Campus, ASTM Reading Room, Incorporated by Reference (IBR) Standards Hosted by ANSI, National Institute of Standards and Technology (NIST) Free Standards List, UL Standards, NFPA Standards, Other(s)_____

11) What freely available standards educational resources are provided? Choose all that apply. Self-created video tutorials (add link), Self-created print tutorials (add link), ASTM Students & Professors, IEEE University, ANSI StandardsLearn.org, ANSI Education & Training, Other(s)_____

12) Is there a particular librarian associated with standards listed on the website? (Yes (Provide link), Not, unsure)

Appendix B

Faculty Survey Questions

[This survey was built into Qualtrics]

Thank you for your participation in this survey.

There are 14 questions that should take approximately 5-10 minutes to complete.

For the purposes of this survey, we consider "standards" to be documents produced by domestic or international organizations which plan, develop, establish, or coordinate voluntary consensus standards using agreed-upon procedures. These bodies may include accredited standards developers (like ASTM International or ISO, the International Organization for Standardization), professional societies (like ASME or IEEE), and industry associations (like NEMA, the National Electrical Manufacturers Association).

1. Approximately how many students are enrolled at your institution?

<5000, 5,001-10,000, 10,001-15,000, 15001-20,000, 20,001-25,000, 25001+

2. Is your institution public or private?

Public, Private

continued on next page

3. Which of these ABET accredited engineering technology bachelor degrees does your institution offer? (Not sure?: Look up Engineering Technology Accreditation Commission (ETAC) programs here: https://amspub.abet.org/aps/category-search?commissions=4). Select all that apply.

- Civil Engineering Technology (BS)
- Computer Engineering Technology (BS)
- Constråuction Engineering Technology (BS)
- Electrical and Electronics Engineering Technology (BS)
- Industrial Engineering Technology (BS)
- Manufacturing Engineering Technology (BS)
- Mechanical Engineering Technology (BS)
- One or more other ET BS program(s) not listed above

4. Which engineering technology programs do you currently teach in? Select all that apply.

- Civil Engineering Technology (BS)
- Computer Engineering Technology (BS)
- Construction Engineering Technology (BS)
- Electrical and Electronics Engineering Technology (BS)
- Industrial Engineering Technology (BS)
- Manufacturing Engineering Technology (BS)
- Mechanical Engineering Technology (BS)
- One or more other ET BS program(s) not listed above

5. How long have you been teaching in engineering / engineering technology programs?

- 0-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21 or more years

6. Have you had any non-academic (e.g., industry) work experience during your engineering / engineering technology career?

- Yes
- No

6a) [If 6 yes}. Please generally describe your non-academic work experience.

6b) [if 6 yes]. Discuss the role, if any, technical standards played in your non-academic work experience.

7. On a scale of 1 to 5, with 5 being the highest, rate your knowledge of technical standards.

[1-No knowledge 5-Very knowledgeable]

8. How did you become educated about technical standards? Select all that apply.

- During my undergraduate education
- During my graduate education
- On the job as an academic
- On the job in a non-academic position
- Professional association offerings (e.g., workshops, conferences)
- Other, please explain:
- I don't feel educated about technical standards.

continued on next page

9. Do you currently integrate technical standards into your courses?

- Yes
- No

9a. [If 9 Yes] How long have you integrated technical standards into your courses?

- 0-5 years
- 6-10 years
- 1-15 years
- 16-20 years
- 21 or more years

9b. [If 9 Yes] Please briefly describe which classes you integrate technical standards into (e.g., level, course topic):

9c. [if 9 Yes]: Please briefly describe how you integrate standards into your classes. (e.g., only specific standards, broad approach, directly to a specific application)

9d. [if 9 Yes] What organizations develop the standards you use in class(es)? Select all that apply:

- ASTM
- ASME
- IEEE
- SAE
- UL
- NFPA
- ISO
- IEC
- Other, please list:

9e. [if 9 Yes] How do you obtain the standards documents you use in your classes? Select all that apply.

- Campus library
- Purchase with my own funds
- Purchase with department funds
- Professional society memberships
- Find freely available standards online!
- Other, please explain:

9f. [if 9 Yes] Do you partner with the library or librarians at your institution to integrate standards content into your classes?

- Yes
- No

9g. [If 9f Yes] Please describe how you partner with the campus library / librarians:

9h. [If 9 No]: Why don't you integrate standards into your engineering technology classes? Select all that apply.

- Not relevant to my course(s)
- Not enough time
- I don't feel like I have the expertise
- Standards are too expensive
- Other, please explain:

10. Would you be interested in becoming educated (or further educated) about standards?

- Yes
- No
- Maybe

continued on next page

10a. [If 10 a or c] Please describe the standards related topic(s) you are (or may be) interested in learning about:

10b. [If 10 a or c] What is your preferred format for learning about these standards topics? Select all that apply.

- Professional association offerings (e.g., workshops, webinars)
- Online courses
- Self-paced tutorials
- Outside speaker(s) seminar/workshop for my department/school
- Other, please explain:

11. Please discuss any barriers that prevent faculty from implementing standards into the ET curricula.

12. Please share any ideas you have to promote integration of standards into ET curricula.

13. Please share any other comments that come to mind about standards in ET curricula or in general.

14. We are offering a drawing for two $50 Visa gift cards as an incentive for completing this survey.

Do you wish to receive this incentive? If you answer yes, you will be taken to a form where you can enter your name and email address for a random drawing of respondents.

- Yes
- No

14a. [If 14 Yes] Enter link to a separate Qualtrics form that asks for the respondent's name and email.

Margaret Phillips

Margaret Phillips is an associate professor of library science and associate department head in the Purdue University Libraries & School of Information Studies. As libraries faculty, Margaret specializes in access to technical information resources, instructs students on how to identify, locate, critique, and retrieve information and collaborates with faculty colleagues in the College of Engineering and Purdue Polytechnic Institute to teach specialized data and information courses and/or participate as a member of faculty teaching teams. Her research interests include information literacy in engineering and technology curricula, technical standards, and information-seeking behavior of engineering and technology students and professionals.

Paul McPherson

Paul McPherson is an associate professor of Practice in the School of Engineering Technology at Purdue University. Professor McPherson's areas of expertise includes mechanical design and quality control, where one of the key areas of focus is integrating the use of technical standards. Professor McPherson's industry experience and time serving on technical standards committees has led to his research interests in access and integration of technical standards, machine design, and metrology.

Danielle LeClerc

Danielle LeClerc is a 2021 graduate of Purdue University, where she earned her BS in Mechanical Engineering Technology. Danielle then served as a graduate teaching assistant at Purdue University during the Fall 2021 academic term ,where she aided in teaching mechanical design courses as well as completed research to help determine the availability of technical standards through libraries at ABET-accredited institutions. In January 2022, Danielle transitioned into industry, where she now serves as a technical support engineer at Endress+Hauser.