



One Size Does Not Fit All: Common Practices for Standards Collections and Management

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Abstract

There are numerous studies in the engineering literature about standards, though practical information on standards collection management in libraries is somewhat limited. This study builds upon previous studies but with both a broader scope and more granularity. The purpose is to fill gaps and add to the existing literature on standards collections and use. The workflow for collection development and management practices for standards, like other special resources, are according to each institution's preferences, clientele, campus culture, budget, and needs. To deepen the understanding of standards management in libraries, this study uses a larger sample size than previous studies found in the literature, through a survey of 336 academic libraries in the United States at institutions offering four or more Accreditation Board for Engineering and Technology (ABET) accredited engineering programs. The survey includes questions in areas that have not been studied before, such as institutional size, the highest degree offered, collecting intensity, and demand levels. Findings confirm some results of previous studies, but also show some new and unexpected findings.

Keywords: Standards, Standards collection and management, Standards access, Standards education, Standards use

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Introduction

There is no single definition for technical standards. The International Organization for Standardization (ISO) states that “Standards are the distilled wisdom of people with expertise in their subject matter and who know the needs of the organizations they represent – people such as manufacturers, sellers, buyers, customers, trade associations, users, or regulators” ([International Organization for Standardization, 2021, para. 2](#)). The American National Standards Institute states that “Standards are the infrastructure for innovation, a critical component in bringing technologies from the lab to the market. Standards create a common language for trade and improve quality of life by enhancing safety, security, interoperability and the environment” ([American National Standards Institute, 2020, p. 3](#)). One of the more concise definitions is provided by Thompson ([2011](#)) stating that a standard is “an agreed way of doing something the same way each time” (p. 9).

Increases in population, technology utilization, and global trade have contributed to the growing number of published standards, escalating their importance and their utilization ([Khan et al., 2013](#); [Taylor, 1999](#)). Since standards outline accepted practices and save time in design, 69% of practicing engineers report using standards, more than any other resource besides their employer's intranet ([Phillips et al., 2019](#)). Phillips et al. ([2019](#)) also reported that 83% of engineering students use standards annually.

Academic institutions have the task of producing industry-ready engineers that will succeed in our complicated, interconnected, and rapidly changing society. Therefore, their engineering students should become familiar with relevant standards and understand how standards are created, published, discovered, and deployed. The Accreditation Board for Engineering and Technology (ABET), the main body that accredits engineering and technology programs in the United States and increasingly globally, recognizes this concept. Criterion 5d of the Engineering Accreditation Commission (EAC) of ABET requires engineering curriculum to include “a culminating major engineering design experience that ... incorporates appropriate engineering standards and multiple constraints” ([Accreditation Board for Engineering and Technology, 2019, p. 6](#)).

Due to the importance of standards in national and international economies and the accreditation of engineering programs, academic libraries supporting science, technology, engineering, and mathematics (STEM) should collect standards or provide access to them. However, due to their unique nature, standards acquisition and management are challenging for libraries. There is a large number of standards from numerous organizations, they often have atypical restrictions or licenses, are expensive, and have rapid obsolescence. Indexing is rare or non-existent, hence standards are not easily discoverable. Therefore, standards acquisitions do not usually follow normal collection management workflows and practices. Standards are not

available through regular book purchasing channels, instead, they must be obtained directly from their publishers and specialized vendors. Some are without bindings and now, some are available only in digital format, often with rights management software limiting use. Standards do not usually have item records in OCLC, hence almost in all cases, need original cataloging. They are challenging to borrow using conventional methods for resource sharing or interlibrary loan (ILL).

Literature Review

Due to the unique nature of standards and high cost, libraries must purchase and collect standards in cost effective ways. According to Melgoza (2002), subscription services can be expensive and divert funds from other engineering-related materials. Musser (1990) also stated that given limited resources that exist in most academic libraries, it is difficult to justify a comprehensive purchase of standards. Using the on-demand purchasing, either through library-mediated or direct user approaches, was seen as an alternative means and has been well-documented in the literature (Dunn & Xie, 2017; Mathews, 2006; Melgoza, 2002; Musser, 1990; Pellack, 2005; Phillips, 2019; Taylor, 1999). Pellack (2005) and Mathews (2006) found that 60% and 63% of institutions, respectively, provide individual standards through on-demand purchasing. While widely used, on-demand purchasing is not without its challenges. Phillips (2019) addressed two challenges of on-demand purchasing: (1) aggregator platforms do not have link resolvers, and (2) uncertainty of the number of users for one digital copy, which usually has a single user license.

Another way engineering libraries provide access to standards is through ILL. While ILL is used, Musser (1990) concluded that standards developing organizations' (SDOs) restrictions coupled with copyright do not always make copying print standards for ILL a successful option. Later, Pellack (2005) at Iowa State University mentioned the difficulty of locating holdings for print standards because standards are not cataloged and thus not in OCLC, a global membership organization for library management, discovery, cataloging, and resource sharing. However, Phillips (2019) noted that "libraries still try this method, especially for older standards" (p. 340). Switching print subscriptions to electronic format is expensive but purchasing individual standards through on-demand will save subscription costs, improve access, and save shelving space (Pellack, 2005). Pellack (2005) stated that deposit accounts can be a successful approach to acquiring some library materials such as standards. Taylor (1999) indicated that a combination of standing orders, unique selection, on-demand, and ILL could be a best practice. Such an approach might be called a hybrid model.

Budgeting for standards presents another set of challenges and is driven by local circumstances. Some libraries do not have separate budgets for standards (Pellack, 2005; Wetzel et al., 2021). The budgeting for on-demand purchasing is especially challenging due to the uncertainty of the number of requests a library could receive in a year (Pellack, 2005). ILL also has budget implications even though it is reciprocal. Spending on standards varies with respect to the budget situation of academic libraries. According to Pellack (2005), most Association of Research Libraries (ARL) responding spent between \$101 and \$1,000 with only one spending between \$10,000 and \$20,000. In

a more recent study, Wetzel et al. ([2021](#)) found that most of the ARL libraries responding spent \$3,000 or less annually with only five libraries spending between \$10,000 and \$20,000.

The need for standards education is unquestionable. It is already established that standards are an integral part of professional engineering practice, therefore, it is incumbent on libraries to provide access and offer standards education, though the first exposure of students to engineering literature and standards is often during co-op experiences ([Jeffries & Lafferty, 2012](#)). ABET's criteria for assessing engineering programs also states that standards should be incorporated in the curriculum culminating in a major design experience ([Kelly, 2008](#); [Murphy et al., 2011](#)). In addition, Leachman and Pezeshki ([2015](#)) stated that their survey strengthened the notion that students need to be familiar with the existence and importance of standards. Rodrigues ([2001](#)) mentioned that corporations expect their newly hired engineers to be able to hit the ground running. Therefore, SDOs have become increasingly involved in standards education. For example, the American Society of Mechanical Engineers (ASME) offers "introduction to standards" guidelines ([Murphy et al., 2011](#)). In addition, the American National Standards Institute (ANSI) and National Institute of Standards and Technology (NIST) sponsored a workshop to bring industry and academics together primarily to define standards education and research agenda for higher education ([Kelly, 2008](#)). A National Science Foundation (NSF) initiative was awarded to the Institute of Electrical and Electronics Engineers (IEEE) to "help develop tutorials and case study modules for students and encourage standards education at college campuses" ([Khan et al., 2013, p. 2](#)). According to Harding ([2011](#)), students must understand the interplay of the three fundamental dynamics of standards: technology, economics, and politics. They should also know how standards play a part in their lives, and how to think critically about standards development and technology solutions.

To encourage standards education in higher education, both ASTM (formally American Society for Testing and Materials) and ISO developed awards for educational institutions or professors who incorporate the use of standards as an integral part of classroom assignments ([Harding & McPherson, 2010](#)). Harding and McPherson ([2010](#)) also reported that in 2006, ISO in conjunction with the Japanese Industrial Standards Committee introduced a "Higher Education in Standardization" monetary award, and in 2009, ASTM introduced the "professor of the year" monetary award ([Harding & McPherson, 2010](#)). In the same vein, NIST Standards Services Curricula Development Cooperative Agreement program awards funding for projects that integrate standards education into undergraduate and graduate curricula ([Phillips & Huber, 2017](#)).

As part of this study, the authors seek answers to the following research questions.

1. Do libraries of engineering schools have standards in their collections regardless of enrollment size?
2. Do engineering libraries share standards through interlibrary loan?
3. What acquisition methods do engineering libraries employ for collecting standards and what payment methods do they use?
4. How do libraries manage individual standards they purchase through on-demand?

5. Do engineering libraries engage in standards' education?
6. Who on campus is using standards and for what purpose?

Methods

A survey was developed to examine the research questions. The population studied is made up of the 336 academic libraries in the United States that have four or more engineering programs accredited by one or more ABET commissions. The list was selected from the group of institutions accredited by ABET as of 2019. The reason for this is to ensure that the institutions in the study are well-invested in engineering education. Factors that informed the formulation of the questions in the survey are the six research questions, gaps and omissions in the literature, and suggestions for further research found in previous studies. Questions on the survey instrument included degrees offered, and uses by non-academic entities, since these areas were not included in previous studies. The authors used the survey designer in REDCap ([Harris et al., 2009](#)) to create a 22-item instrument that consisted of 21 closed-ended questions, eight of which included open-ended options, and there is one stand-alone open-ended question ([Appendix](#)). Participants were able to skip survey questions if they desired to encourage participation. The questions range from student enrollment (i.e., FTE) to acquisition methods, access, use, sharing through ILL, level of demand, collection intensity, management, and standards education.

To distribute the survey, it was necessary to use multiple sources to obtain the email addresses of the librarians in the study population. The institutions' websites and the American Society for Engineering Education *Engineering Libraries Division Directory of Members* served that purpose ([American Society for Engineering Education, 2019](#)). In all cases, the survey invitation stated that if the person receiving the survey is not in charge of collection and management of standards, it should be passed on to the appropriate person. The survey was administered through REDCap with the approval of Virginia Commonwealth University Institution Review Board (IRB) ID: HM 20016135 between January and April 2020, and automatic reminders were set up in REDCap for every 14 days.

Results

Eighty-five recipients responded to the survey, which is approximately a 25% response rate and represents 85 individual institutions. Of the responding libraries (n=85), 74% offer doctorate degrees as the highest degree, 15% offer master's and 11% offer bachelor's. With respect to the engineering programs offered at those 85 institutions with multiple responses possible, the top five engineering programs were electrical engineering and mechanical engineering at 94%, computer science and civil engineering at 82%, computer engineering at 78%, and then marine engineering and petroleum engineering are the least at 9% and 8% respectively. There were also 19 write-in responses that totaled 22%, though none of the individual write-in responses accounted for more than 2% of any individual engineering field. Many of the write-in responses were unique programs or variations of those listed on the survey. As mentioned in the methods section, respondents were allowed to skip questions, and so sample sizes vary among responses.

The six enrollment-based categories form the basis for the analysis. Figure 1 shows the total number of institutions responding according to the enrollment-based categories. Figure 2 shows the number of institutions subscribing to or purchasing standards by student enrollment. Of the 85 responding libraries, twelve do not collect standards. Their reasons for not collecting standards varied though cost was the main reason. All twelve chose “cost” as the reason with one respondent also choosing “unfamiliarity with standards,” another choosing “no demand”, and yet another one also choosing “difficult to catalog, and lack of shelf space.”

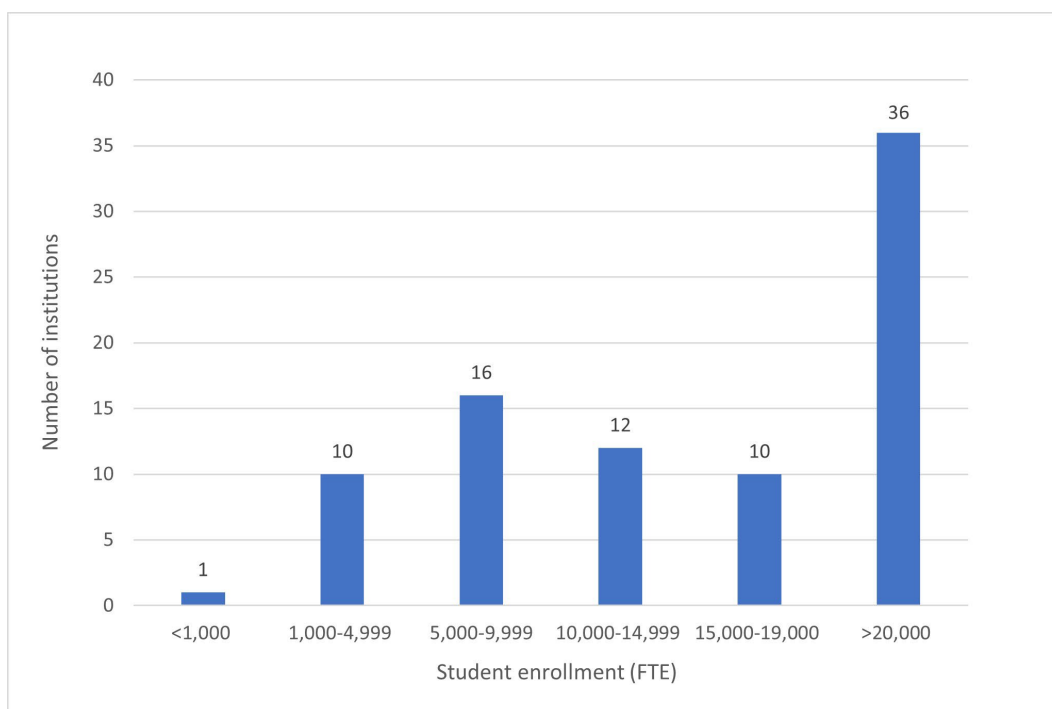


Figure 1. Responding institutions by student enrollment (n=85)

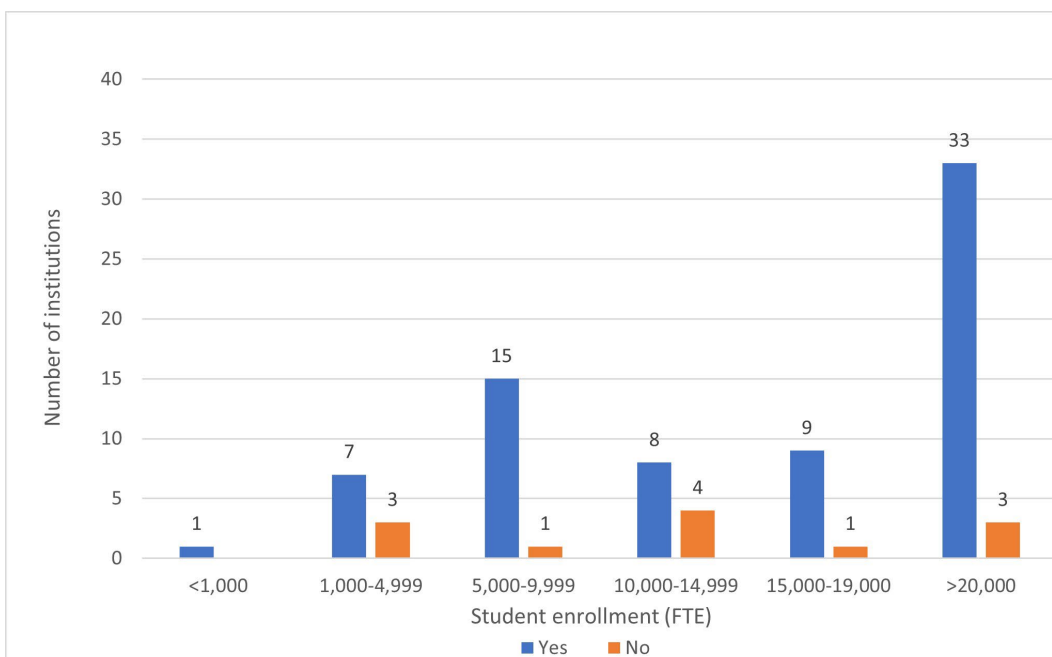


Figure 2. Institutions that subscribe or purchase standards by student enrollment (n=85)

Standards Collection

Libraries acquire standards in multiple ways such as subscriptions, on-demand and ILL. However, the results of this study show that most libraries have subscriptions. Out of 85 libraries, 63 (74%) have subscriptions, while 22 (26%) do not (Table 1).

Table 1. Libraries that use subscriptions for standards (n=85)

Subscription	Count	Percentage
Yes	63	74%
No	22	26%

Of the 45 SDOs listed on the survey, the most frequently mentioned by those who subscribe are: Institute of Electrical and Electronics Engineers (IEEE) (49, 78%), ASTM, formally (American Society for Testing and Materials) (45, 71%), Society of Automotive Engineers (SAE) (13, 21%), American Society of Mechanical Engineers (ASME) (12, 19%), and American Society of Civil Engineers (10, 16%). Of those that have subscriptions, 52 (83%) offer a doctorate as the highest degree, seven (11%) offer master's, while four (6%) offer bachelor's. Figure 3 shows libraries that have subscriptions by student enrollment.

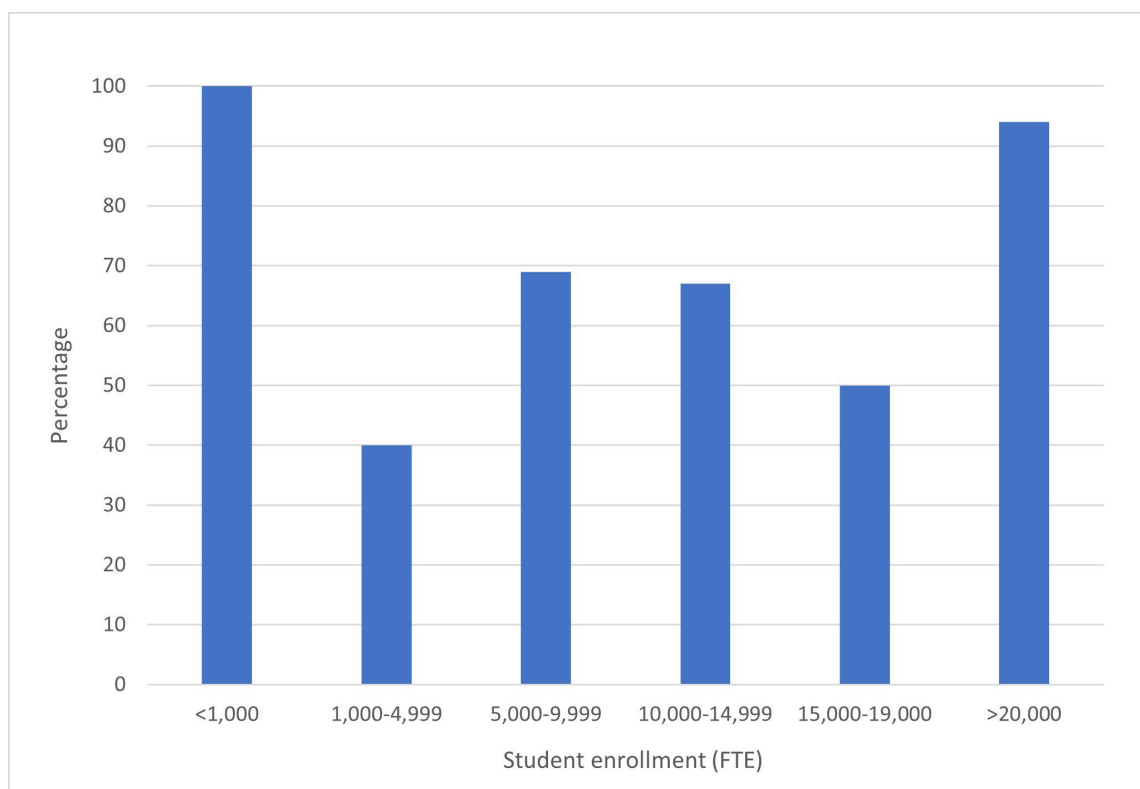


Figure 3. Institutions that have subscriptions to standards by student enrollment (n=63)

Table 2. Libraries that use on-demand for standards (n=84)

On-demand	Count	Percentage
Yes	52	62%
No	32	38%

On-demand purchasing is another way standards are acquired by libraries (Table 2). In this model, a library responds to a patron's request for standards that are not in the collection by purchasing individual standards, either in print or online, just-in-time on a one-time basis from vendors, including aggregators or SDOs. Of the 52 that use on-demand purchasing, 42 (81%) offer a doctorate degree as the highest degree, while seven (13%) offer master's, and three (6%) offer bachelor's.

Table 3 summarizes the vendors used to acquire standards through on-demand purchasing. Of the 18 vendors mentioned, both in the survey and in the text option, the top three are Techstreet, IHS Markit, and ANSI Webstore. All three are aggregators offering standards from numerous SDOs. Libraries also purchase individual standards directly from SDOs as indicated by many of the write-in responses; these included: American Association of State Highway and Transportation Officials (AASHTO), American Concrete Institute (ACI), American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), ASTM (formerly known as American Society for Testing and Materials), International Organization for Standardization (ISO), National Fire Protection Association (NFPA), National Institute of Standards and Technology (NIST), and the Society for Automotive Engineering (SAE). When libraries acquire standards through on-demand purchasing, they use a variety of payment methods. Of those using on-demand purchasing (n=52), 33% use a credit card, 13% use a deposit account, 13% use invoicing, 10% use the same method as for book orders, 2% use a purchase order, 2% use state guidelines and 27% did not specify a payment method.

Table 3. Vendors used for on-demand purchasing (n=52)

Vendors	Count ^a	Percentage
Techstreet	31	60%
IHS Markit Standards Store	23	44%
ANSI Webstore	17	32%
MADCAD	4	8%
Document Center	3	6%
SAI Global	2	4%
BSI Shop/British Standards Online	1	2%
Others: AASHTO, ACI, ANSI, ASME, ASTM, IEEE, ISO, NFPA, NIST, Reprints Desk, SAE	11	21%
^a This question allows for multiple responses.		

In addition to licensing standards through subscriptions and purchasing on-demand, libraries can also obtain individual standards through ILL though the results of this study show that it is not a common practice. Out of the 85 responding libraries, only 15 (18%) borrow standards through ILL while 36 (42%) do not, and 34 (40%) indicated that it depends on the license. When asked if their institution obtained standards for their patrons via ILL, 55 (65%) said yes, 29 (35%) said no (n=84). It is primarily the libraries at larger institutions that loan and borrow standards through ILL.

Access Points

In addition to collecting standards, libraries must make them accessible to patrons. When asked “What are the access points for standards in your institutions,” the respondents indicated: 73% through library databases, 56% through the discovery layer, 34% through ILL or document delivery, 22% Other, and 13% Google Scholar (n=82). While Google Scholar does contain the occasional standard, it’s not really an access point or source, and the provenance of the standards discovered is questionable. So, it was surprising to see it chosen so frequently. The “Other” category included library catalogs, email, homegrown database, and individual websites of SDOs.

Cost of Standards

Table 4 and Table 5 show the respondent’s annual subscriptions and on-demand expenditures for standards, respectively. Almost 75% of libraries spend less than \$20,000 annually on subscriptions with half of those spending less than \$5,000. Overall, libraries spend considerably more on standards through subscriptions than on-demand.

Table 4. Annual subscription expenditures
(n=65)

Subscription Expenditures	Count	Percentage
\$0-\$4,999	24	37%
\$5,000 - \$9,999	9	14%
\$10,000 -\$19,999	15	23%
\$20,000 - \$39,999	8	12%
\$40,000-\$49,999	4	6%
\$50,000-\$99,999	3	5%
More than \$100,000	2	3%

Table 5. Annual on-demand expenditures
(n=70)

On-demand Expenditures	Count	Percentage
\$0-\$499	27	39%
\$500 - \$999	18	26%
\$1,000 -\$1,999	11	16%
\$2,000 - \$3,999	8	11%
\$4,000-\$4,999	3	4%
More than \$5,000	3	4%

Use of Standards

When asked what standards are used for and by whom, with multiple responses possible, results show that the use of standards is not limited to curricula and research

though those were the most frequent responses. Other entities on campus, such as facilities, operations, and legal (e.g., legal counsel), were also indicated. Respondents also reported entrepreneurial innovation needs as being a significant portion, possibly due to intellectual property or technology transfer activities. Responses in the “other” category all indicated other types of curricular and research use (e.g., use for capstone projects, graduate student dissertations, etc.)

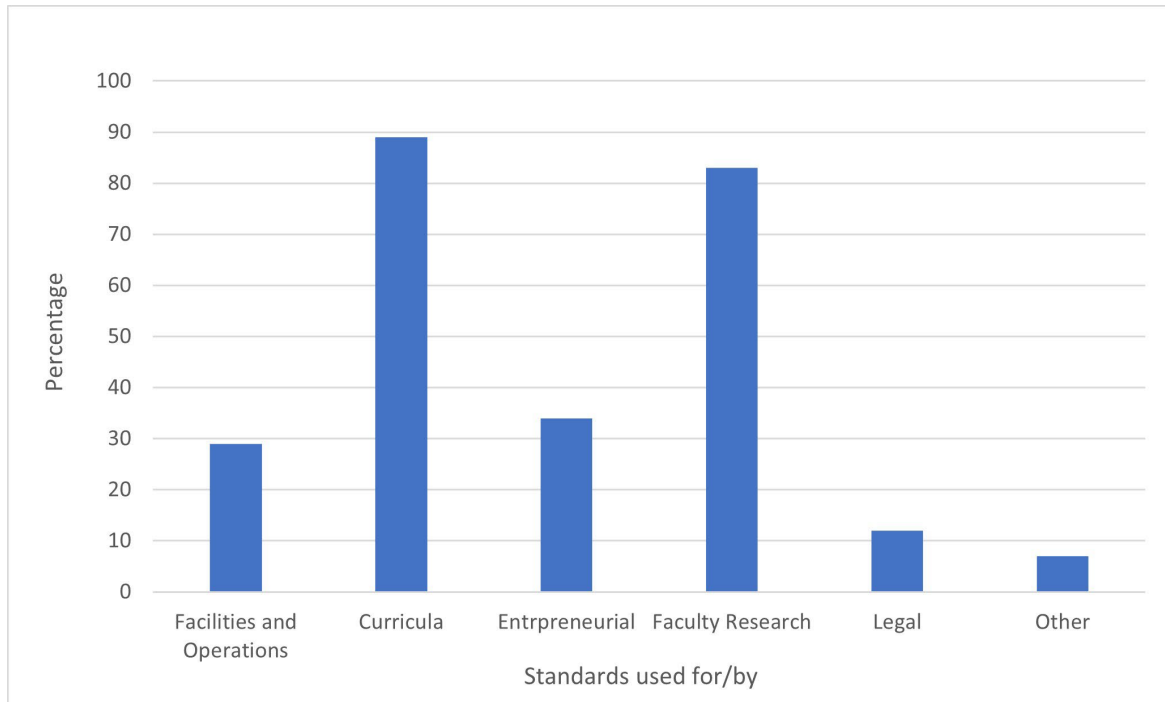


Figure 4. Use of standards campus-wide (n=82)

Collection Intensity

The Research Library Group (RLG) developed a system of collecting levels called RLG conspectus. RLG intended to use it as a uniform evaluation of collections in research libraries. RLG conspectus was last updated in 1997 ([Library of Congress, n.d.](#)) and became part of OCLC in 2006 ([Branin et al., 2000](#)). According to descriptors adapted from the RLG conspectus, there are five levels of collecting activity.

1. Minimal Level - Few selections beyond fundamental works.
2. Basic Information Level: A collection of up-to-date general materials that serve to introduce and define a subject and to indicate the varieties of information available elsewhere.
3. Instructional Support Level: A collection that is adequate to support undergraduate and most graduate instruction.
4. Research Level: A collection that includes major source materials useful for dissertation and independent research.
5. Comprehensive Level: A collection which so far as is reasonably possible includes all significant works of recorded knowledge.

Responding libraries collect standards at varying intensities (n=85). Most libraries collect at a Minimal level, (32%), followed by the Basic Information (28%), Instructional Support (18%), and Research (21%) levels. Only 1% of responding libraries are collecting standards at the comprehensive level.

Management of Standards

Management of standards is as important as their acquisition. One of the questions on the survey is, “How do you manage the standards you purchase on-demand?” The responses are shown in Figure 5 with multiple answers allowed. Most libraries added the print standards to their collections, though almost half indicated giving a pdf version to the requestor. Of those responding, 14% indicated that they both added the print to the collection and provided a pdf version to the requestor, but not necessarily the same request, and 2% indicated they archive the standards on the library’s intranet.

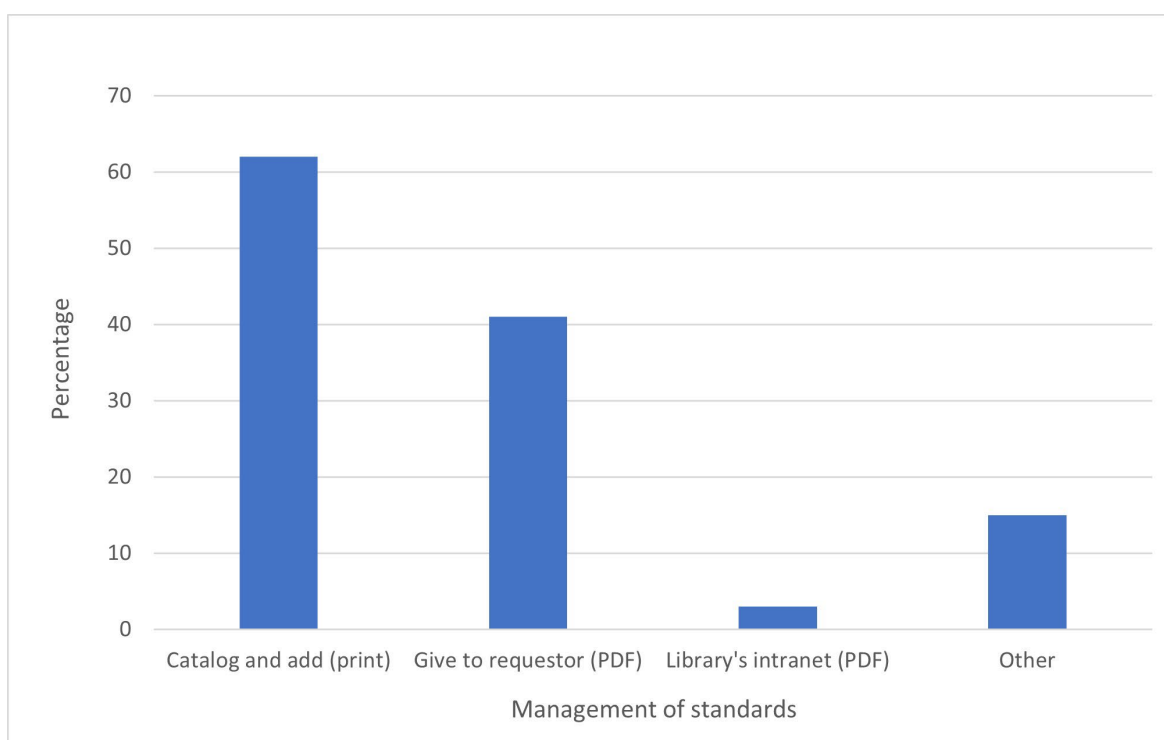


Figure 5. Management of standards acquired through on-demand purchasing (n=61)

The “other” category included the following write-in responses:

- “Send link to new standard.”
- “Give to the requestor, purchase and reassign to the requestor.”
- “Part of library database collection. None in print.”
- “Not cataloged and added to the print collection, manual charge for limited time only.”
- “Give print to the requestor – pdf can only be opened often by one user and groups usually need to review standard.”
- “We only purchase standards available online through Techstreet (unless print is the only option). Print standards will be cataloged and added to the collection. Online standards are only discoverable through Techstreet.”

- “Add to homegrown database”
- “IHS Markit Website as the host”
- “Individual SDO websites”

Standards Education

As standards are critical to engineering education per ABET EAC Criterion 5d, some libraries see it essential to teach standards use in engineering design courses. When asked, do you teach standards use, 59% stated “Yes” and 41% stated “No” (n=85). Figure 6 shows the teaching of standards use by student enrollment. Excluding one institution with <1,000 students, the percentage of institutions teaching standards was highest for those with the largest student enrollment, though less than half reported teaching standards. The mid-sized institutions also taught standards, but even fewer reported teaching standards compared to the largest institutions. Undergraduates are the largest group receiving standards education, followed by graduate students, and faculty (Table 6). The one “other” was a write-in for “researcher.”

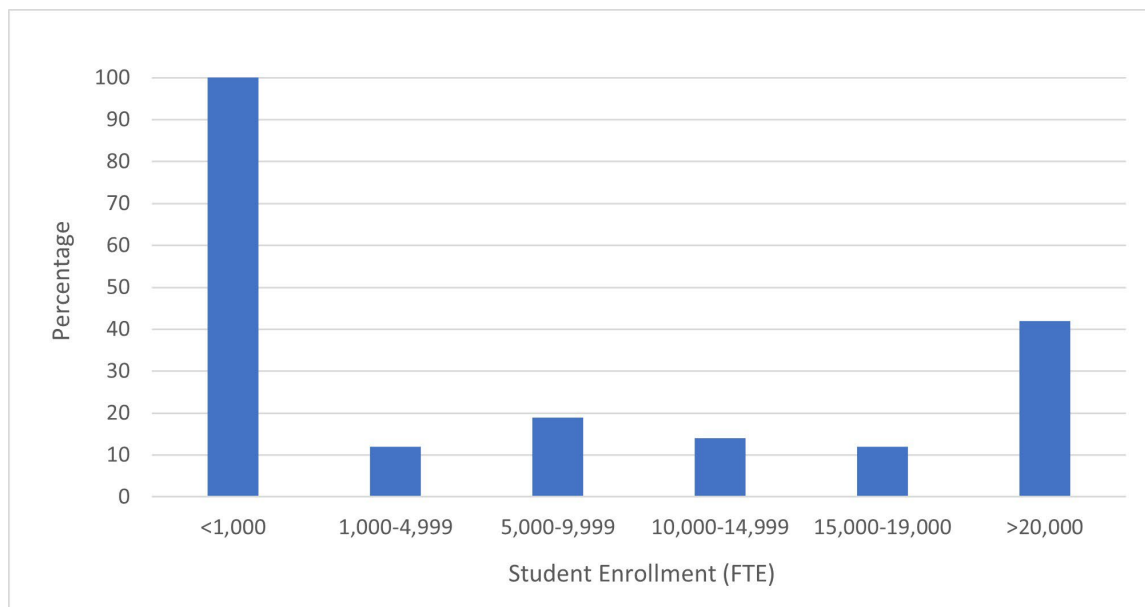


Figure 6. Shows teaching standards use by student enrollment (n=85)

Table 6. Teaching standards by group (n=35)

Group	Count ^a	Percentage
Undergraduates	34	97%
Graduates	18	51%
Faculty	7	20%
Staff	0	0%
Other	1	3%
^a This question allows for multiple responses.		

Demand for Standards

The demand for standards remained the same for 49% of responding libraries over the previous couple of years, while 48% indicated that it is increasing and 4% indicated demand was decreasing (n=82). Thirty-three individual institutions gave reasons for changes, and these vary among institutions. Most respondents see growth as being due to more teaching and experiential learning, more outreach as part of doctoral student research, new faculty encouraging students to use standards in support of projects, and citations in research documentation. Other reasons include emphasizing standards in engineering programs to meet accreditation expectations and demand for capstone courses. The rise in the use of standards is also due to awareness through the Internet, increased outreach to relevant departments, use by more faculty and by other programs outside engineering, and assurance that the libraries will provide access. Others are new engineering programs, and new faculty, use by more people in the community, and more awareness of standards. The following statements exemplify a lot of the comments: (1) "I'm sure there is a variety of reasons, but one guess is the increase in technology transfer opportunities for laboratories on campus to license or spin off their work", (2) "Due to change in ABET requirements, more senior project classes are interested in using standards", and (3) "Demand for electronic access to international standards is exceptionally high, but libraries cannot always satisfy that demand for several reasons, including cost, licensing issues, and more."

Discussion

The findings of this study confirm some issues raised in previous studies but also add some new perspectives. It confirms that acquisition of standards is paramount for engineering libraries as documented in the literature ([Phillips, 2019](#); [Schlembach, 2001](#); [Taylor, 1999](#); [Wetzel et al., 2021](#)). This study introduces a significant level of granularity in contrast to previous studies, such as student enrollment and highest degree awarded. Of particular interest was the impact student enrollment size plays in standards collections and management. Results show some correlations between student enrollment size of institutions and the acquisition of standards. The larger the institution, the more likely their collection includes standards. This may be due to more engineering programs, more researchers, and more graduate students. For example, most of the libraries that acquire standards either through subscriptions or on-demand offer doctorate degrees as the highest degrees. Mid-size institutions that offer master's and bachelor's degrees as the highest degrees are also acquiring standards for their collections, as might be expected if supporting ABET-accredited engineering programs, though to a lesser extent. This shows that standards have a place in academic libraries irrespective of size or degree, but that individual institutions act according to their clientele base and budget.

Though libraries often need to collect standards, cost has always been the challenge as indicated in the literature ([Dunn & Xie, 2017](#); [Melgoza, 2002](#); [Murphy et al., 2011](#); [Musser, 1990](#); [Pellack, 2005](#); [Schlembach, 2001](#)). The results of this study also show the same constraints. All the libraries that do not collect standards mentioned cost as the main reason. However, libraries still provide standards at point-of-need. Standards are obtained in multiple ways, including subscriptions, on-demand purchasing, and ILL.

Most libraries in this study subscribe to standards directly through SDOs, whereas on-demand access is mainly through aggregators such as Techstreet, IHS, and ANSI Webstore. Similar scenarios are reported by Schlembach (2001), Taylor (1999), and Wetzel et al. (2021). As in those same studies, libraries continue to provide access to standards through one-time on-demand purchasing due to increasing cost as seen in this study. Another way libraries provide access to standards for their patrons is through ILL.

Previously, when standards were predominantly print, ILL was considered a good way of obtaining standards not in the library's physical collection. As standards transitioned to electronic, along with restrictive licenses and digital rights management that restricted access to only one user, lending and borrowing standards became a less feasible option. In addition, standards are not usually cataloged, and as such not discoverable in OCLC. As a result, only a small percentage of respondents in this study lend standards through ILL, though more libraries use ILL to obtain standards for their patrons. As the ability to collect standards depends on the budget, it also affects collecting intensity. Almost 80% of the institutions reported collecting standards at only the minimal, basic information, or instructional support levels. Few collected at the research level and only one stated that they collected at the comprehensive level. This shows commitment to satisfying curricular and research needs, but not to building comprehensive standards collections. Overall, respondents reported the demand for standards increasing or staying the same with few libraries reporting decreasing levels.

Academic programs are not the only ones that use standards. Interestingly, there are a few other user groups that may be using standards for a variety of reasons. This study found standards being used by campus facilities and operations, entrepreneurial services, and legal services. Wetzel et al. (2021) also found other campus-wide user groups such as campus facilities, campus IT, and health care. Similarly, both studies found the demand for standards increasing or staying the same with few libraries reporting decreasing levels. Such findings may help libraries garner support from the institution's administration for funding for standards.

Apart from introducing a significant level of granularity, this study uses a large population size of 336 and analyzed 85 responses in contrast to previous studies such as that by Dunn and Xie (2017) which analyzed 45 responses or Wetzel et al. (2021), which used 109 ARL institutions, 12 survey questions, and analyzed 42 responses. This study categorizes the institutions under investigation according to academic degrees awarded. Eighty-three percent that offer doctorate as the highest degree use subscriptions to acquire standards. This may indicate that libraries from institutions that offer doctorate degrees have a greater commitment, or at least the financial resources, to use the subscription method to provide a steady uninterrupted supply of standards for research needs.

Inasmuch as libraries collect standards, it is important that they offer standards education in compliance with ABET criteria that students learn and apply standards in their class projects. The undergraduate engineering degree programs are the training ground for producing future engineers. Meah (2019) described the process to incorporate major design experiences that prepare engineering students for professional

engineering practice. In response to the question “do you teach standards,” this study found that only half of the respondents taught standards. This is in comparison to Khan et al. (2013), which surveyed faculty and institutions, where the responses were 71% “yes” and 29% “no.” So, faculty are doing more than libraries as far as standards education is concerned so that students could satisfy employer expectations. This may suggest an opportunity for librarians to be more involved in standards education. As the current study shows, undergraduates are the highest percentage receiving standards education. In Khan’s (2013) study, 66% of students said they incorporated industrial standards in their senior design projects, which confirms that undergraduates are important beneficiaries of standards education. This is a sentiment echoed by Mathews (2006) since it is essential that undergraduates are well-grounded in standards education in order to thrive on their first employment.

Limitations

One limitation to the study is that the survey allows respondents to skip questions to encourage participation. This creates challenges to interpretation of the results. Another limitation was the more limited response of libraries from smaller institutions, though the number of smaller institutions with four or more accredited ABET programs may be a smaller population and these results reflected it.

Conclusion

Standards collection and management differ across institutions. Nevertheless, some similarities exist. Though some traditional library practices are similar, one size does not fit all in standards collections, uses, and management. Each library does what is best for the local community. What can libraries do to help themselves? One recommendation may be to identify entities on campus outside of teaching and research that use standards to garner increased support, financial or otherwise. Since institutions of all sizes use standards, there may be opportunities for consortial agreements to license subscriptions. Standards developing organizations could also help libraries by relaxing rules for use and sharing of standards, as well as making them more affordable and possibly providing limited free access for educational purposes. Standards collection and management are important and can be challenging, but libraries have been and continue to seek out solutions to meet the needs of their community.

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Appendix. Survey

Approximately, what is the student FTE enrollment of your institution?	<input type="checkbox"/> < 1000 <input type="checkbox"/> 1000-4999 <input type="checkbox"/> 5000-9999 <input type="checkbox"/> 10000-14999 <input type="checkbox"/> 15000-19999 <input type="checkbox"/> >20000
What is the highest degree in engineering offered at your institution?	<input type="radio"/> Bachelor's <input type="radio"/> Master's <input type="radio"/> Doctorate
What engineering fields are offered at your institution? (please check all that apply).	<input type="checkbox"/> Aeronautical/ Astronautical/ Aerospace Engineering <input type="checkbox"/> Agricultural/Biological Engineering <input type="checkbox"/> Biomedical Engineering <input type="checkbox"/> Chemical Engineering <input type="checkbox"/> Chemical & Biological Engineering <input type="checkbox"/> Chemical & Life Sciences Engineering <input type="checkbox"/> Civil Engineering <input type="checkbox"/> Computer Engineering <input type="checkbox"/> Computer Science <input type="checkbox"/> Construction Engineering <input type="checkbox"/> Engineering Science <input type="checkbox"/> Electrical Engineering <input type="checkbox"/> Environmental Engineering <input type="checkbox"/> Industrial Engineering <input type="checkbox"/> Marine Engineering <input type="checkbox"/> Materials Engineering <input type="checkbox"/> Materials Science/Materials Engineering <input type="checkbox"/> Mechanical Engineering <input type="checkbox"/> Petroleum Engineering <input type="checkbox"/> Software Engineering <input type="checkbox"/> Transportation Engineering <input type="checkbox"/> Others (please specify)
Others (please specify) _____	

Does your library's collection include technical standards?	<input type="radio"/> Yes <input type="radio"/> No
If No, why not? (check all that apply)	<input type="checkbox"/> Cost <input type="checkbox"/> Unfamiliarity with technical standards <input type="checkbox"/> Difficult to obtain <input type="checkbox"/> Difficult to catalog/process <input type="checkbox"/> No demand <input type="checkbox"/> Other (please explain)
Other (please explain)	<div></div> <div>(please specify)</div>
Does your library share standards via interlibrary loan, and/or document delivery?	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> It depends on the License (Please explain)
Do you obtain standards for your patrons via interlibrary loan?	<input type="radio"/> Yes <input type="radio"/> No
What is the collection intensity of standards at your institution?	<input type="radio"/> Level 1 (Minimal Level) <input type="radio"/> Level 2 (Basic Information level) <input type="radio"/> Level 3 (Instructional support level) <input type="radio"/> Level 4 (Research level) <input type="radio"/> Level 5 (Comprehensive level)
Do you have a subscription for standards?	<input type="radio"/> Yes <input type="radio"/> No
If Yes, is your subscription through one or more of the following organizations? (check all that apply)	<input type="checkbox"/> American Association of State Highway and Transportation Officials <input type="checkbox"/> American Concrete Institute <input type="checkbox"/> Aerospace Industries Association <input type="checkbox"/> American Institute of Aeronautics and Astronautics <input type="checkbox"/> American Institute of Steel Construction <input type="checkbox"/> American Nuclear Society <input type="checkbox"/> American National Standards Institute <input type="checkbox"/> American Petroleum Institute <input type="checkbox"/> Acoustical Society of America <input type="checkbox"/> American Society of Agricultural and Biological Engineers <input type="checkbox"/> American Society of Civil Engineers

	<ul style="list-style-type: none"> <input type="checkbox"/> American Society of Heating, Refrigerating and Air-Conditioning Engineers <input type="checkbox"/> American Society of Mechanical Engineers <input type="checkbox"/> American Society for Quality <input type="checkbox"/> American Society for Testing and Materials <input type="checkbox"/> American Welding Society <input type="checkbox"/> American Water Works Association <input type="checkbox"/> Business and Institutional Furniture Manufacturers Association <input type="checkbox"/> British Standards Institution <input type="checkbox"/> European Committee for Electrochemical Standardization <input type="checkbox"/> Canadian Standards Association <input type="checkbox"/> European Telecommunications Standards Institute <input type="checkbox"/> International Association of Plumbing and Mechanical Officials <input type="checkbox"/> International Code Council <input type="checkbox"/> International Electrochemical Commission <input type="checkbox"/> Institute of Electrical and Electronics Engineers <input type="checkbox"/> Illuminating Engineering Society <input type="checkbox"/> International Society of Automation <input type="checkbox"/> International Organization for Standardization <input type="checkbox"/> International Telecommunications Union <input type="checkbox"/> Laser Institute of America <input type="checkbox"/> MADCAD <input type="checkbox"/> National Association of Corrosion Engineers <input type="checkbox"/> National Aerospace Standards <input type="checkbox"/> National Electric Code <input type="checkbox"/> National Electrical Manufacturers Association <input type="checkbox"/> National Fire Protection Association <input type="checkbox"/> National Information Standards Organization <input type="checkbox"/> National Institute of Standards and Technology <input type="checkbox"/> Occupational Safety & Health Administration <input type="checkbox"/> Society of Automotive Engineers <input type="checkbox"/> State codes (Building and construction) <input type="checkbox"/> Technological Association of the Pulp and Paper Industry <input type="checkbox"/> Telecommunications Industry Association <input type="checkbox"/> Underwriters Laboratories <input type="checkbox"/> Others (please specify)
<p>Others (please specify)</p> <hr/>	
<p>What are the access points for standards in your institution?</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Through the discovery layer <input type="checkbox"/> Google Scholar <input type="checkbox"/> Library Databases <input type="checkbox"/> Library Interlibrary loan or document delivery

	<input type="checkbox"/> Other
Others (please specify) <hr/>	
Do you acquire standards through on-demand purchase?	<input type="radio"/> Yes <input type="radio"/> No
If Yes, which of the following suppliers/vendors do you use? (check all that apply)	<input type="checkbox"/> ANSI Webstore <input type="checkbox"/> BSI Shop/British Standards Online <input type="checkbox"/> Document Center <input type="checkbox"/> IHS Markit Standards Store <input type="checkbox"/> MADCAD <input type="checkbox"/> SAI Global <input type="checkbox"/> Techstreet <input type="checkbox"/> Others (please specify)
Others (please specify) <hr/>	
Do you use a deposit account with your vendor for on-demand standards purchase?	<input type="radio"/> Yes <input type="radio"/> No
If No, what payment method/methods do you use? Please explain.	<hr/> <hr/>
How do you manage the standards you purchase on-demand?	<input type="checkbox"/> Catalog and add to the collection (print) <input type="checkbox"/> Give to the requestor (pdf) <input type="checkbox"/> Archive in the library's intranet <input type="checkbox"/> Other (please explain)
Other (please specify) <hr/>	
Do you teach standards utilization as part of the library education program?	<input type="radio"/> Yes <input type="radio"/> No
If Yes, who do you teach?	<input type="checkbox"/> Undergraduates <input type="checkbox"/> Graduates <input type="checkbox"/> Faculty <input type="checkbox"/> Staff <input type="checkbox"/> Other (please specify)

Approximately, how much do you spend on standards subscriptions per year?	<input type="checkbox"/> \$0-\$4,999 <input type="checkbox"/> \$5,000-\$9,999 <input type="checkbox"/> \$10,000-\$19,999 <input type="checkbox"/> \$20,000-\$39,999 <input type="checkbox"/> \$40,000-\$49,999 <input type="checkbox"/> \$50,000-\$99,999 <input type="checkbox"/> More than \$100,000
Approximately, how much do you spend on standards on-demand?	<input type="checkbox"/> \$0-\$499 <input type="checkbox"/> \$500-\$999 <input type="checkbox"/> \$1,000-\$1,999 <input type="checkbox"/> \$2,000-\$3,999 <input type="checkbox"/> \$4,000-\$4,999 <input type="checkbox"/> More than \$5,000
In your experience, what is the level of demand for standards in the past couple of years?	<input type="checkbox"/> Increasing <input type="checkbox"/> Decreasing <input type="checkbox"/> Stay the same
Please explain the reason for the decline or increase in the level of demand.	
Please complete the following sentence: Standards are used for/by: (check all that apply)	<input type="checkbox"/> Campus facilities and operations <input type="checkbox"/> Class requirement or curricula <input type="checkbox"/> Entrepreneurial innovation <input type="checkbox"/> Faculty Research <input type="checkbox"/> Legal purposes <input type="checkbox"/> Other (please complete)
Other (please complete)	

Do you have anything else you would like to share with us about standards?	

Q1. I have read the above statement and I understand my rights. I agree to complete the survey.



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