What's Guiding Chemical Engineering?: A LibGuide Content Analysis

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Introduction

Many large research institutions (R1 universities) utilize a liaison librarian model to support teaching and research activities across STEM and other academic departments. Engineering is one of the largest sectors in STEM, and these departments especially need specific support for their research and teaching. This support can be in many areas including resource access, search strategy, publishing, in-class instruction and online learning objects. One of the ways librarians present these resources is through online research guides. LibGuides, a Springshare product, are ubiquitous for this purpose. Over two thousand academic institutions in the United States use the LibGuides platform to provide guides to their users [1].

These guides require regular updating in order to present the most utility to users, however, keeping them up to date after creation is a common struggle for librarians. The field of engineering changes regularly, and so do some of the resources relevant to the field. Some resources, such as individual handbooks or standards may stay relevant for decades while others may become completely obsolete. One example of the latter happened with the third party technical standards aggregator, TechStreet, which was abruptly terminated at the end of 2024, after being acquired by another company. Almost two years later, as of the writing of this paper, there are still multiple engineering research guides that direct users to this resource.

As their original name, pathfinders, suggests, LibGuides were originally designed to "connect patrons with resources" [2] and discussions of best practice have generally centered around their usability [3]. However, since librarians use guides principally as instructional tools, there is a growing body of scholarship arguing that guides should adopt, or at least incorporate, a more "learner centered" approach [3], [4]. At the outset, we anticipated guides would generally use the former, resource oriented approach, however, to what degree was unknown. This study does not attempt to argue how prevalent learner centered pedagogy ought to be on LibGuides; rather, it situates the analysis within this ongoing scholarly conversation.

Staying current in the world of engineering information is valuable. This paper explores what content is most commonly found on chemical engineering LibGuides at research universities. Since research guides also serve as learning tools, we also explore the most common pedagogical approach to presenting information on the guides. Is the information more centered around an efficient experience for intended users, such as focusing on lists; or designed to support the specific needs of learners such as focusing on instructional content [3]? To find out more information, we have conducted a content analysis of LibGuides at R1 research universities in the United States. This study investigates current trends in chemical engineering research guides by analyzing patterns in both content and pedagogical approaches.

Literature Review

Content analysis is a systematic method for examining and categorizing communication artifacts such as documents or web pages in order to identify patterns, themes or trends [5]. Content analysis has been applied in library and information science research since at least the early 1990s, being used especially as digital data sources such as web pages and online research guides became more prevalent [6]. This method allows researchers to assess not only what information is presented but also how it is structured and framed for users. It has been applied to LibGuides, in a growing body of research, especially over the past two decades [7]-[23]. These studies examine various aspects of design including layout, content type, and pedagogical intent. Librarians have conducted studies within specific subject areas as well as across broader institutions contexts, demonstrating the flexibility of content analysis as a research method.

Content analyses of engineering guides are sparse. One study of engineering research guides was conducted over 12 years ago and analyzed mechanical engineering and electrical engineering guides, focusing heavily on content, particularly databases [7]. Another, more recent study focuses on the content presented on engineering education research guides [8]. To date, there are no published content analyses of chemical engineering guides, marking this study as the first of its kind.

The number of guides included in LibGuide content analyses varies widely across studies, ranging from as few as ten guides [9] to as many as one hundred [10]. In most cases, the initial sample set is narrowed down based on inclusion criteria and/or the capacity of the researcher(s) conducting the study. Studies focusing on particular disciplines, such as the humanities, STEM, or social sciences, generally prioritize broad subject guides and exclude sub-topic or course-specific guides [11]-[14]. In contrast, studies not limited to a single discipline may focus on course guides [15] or collections of related but uncategorized guides [16], [17]. Studies undertaken since the rollout and widespread adoption of LibGuides, tended to exclude research guides that do not use the Springshare system, however older studies did consider them [18].

Researchers have used a variety of approaches to select institutions for inclusion in LibGuide analyses. Common strategies include focusing on institutions accredited by relevant professional organizations, such as ABET for engineering programs [7], or members of library consortia such as the Greater Western Library Alliance (GWLA) [16]. Other studies have relied on rankings or evaluative frameworks, including U.S. News and World Report rankings [19], National Research Council (NRC) assessments [11], or Scopus analyses of institutions producing systematic reviews [4]. The Springshare community directory has also been used to identify institutions actively using LibGuides [10], [12], [19], [20].

Across LibGuide content analyses, researchers have examined a range of variables, including guide layout, types of content, and resource categories such as databases, books, and journals. Some studies have focused on the presence of specialized resources, such as “point of contact” information in nursing guides [19] or physician assistant certification resources [21]. More recently, researchers have also examined whether guides adopt a user centered approach, emphasizing lists of resources, or a learner centered approach, incorporating instructional content and explanatory context [4], [13], [15].

Analytical methods vary across studies and include manual coding using matrices [7], [14], [21], [22], survey tools such as Qualtrics [13], [15], computational approaches using Python [9], and qualitative data analysis software such as NVivo [4]. Despite methodological differences, findings from these analyses consistently demonstrate the value of content analysis for informing the creation, evaluation, and revision of research guides. Results are frequently used to guide best practices in LibGuide design and to support librarians, particularly those new to liaison work, in developing effective and pedagogically sound research guides.

Methods

The scope of this study focuses specifically on chemical engineering LibGuides at R1 institutions. The initial, more broad scope of this study reflected the authors' subject liaison responsibilities across multiple engineering disciplines at the time; including, but not limited to, chemical engineering. As the study progressed, it became clear that a comprehensive, multi-disciplinary analysis exceeded our available time and resources. In order to ensure methodological rigor and analytic depth within a manageable framework, we narrowed the focus to chemical engineering guides specifically. This decision was further supported by the absence of prior published content analyses focused on chemical engineering LibGuides and by the prevalence of chemical engineering programs among R1 institutions. Any modifications to the original study design resulting from this refinement are noted where applicable.

The institutions included in our data set are pulled from the *US News and World Report 2023-2024 Best Engineering Schools* list, which includes almost 200 institutions. From the list, we chose a sample set of 50 schools. To ensure representation of highly ranked engineering programs, the set includes the top 20 schools from the list. The remaining 30 institutions were selected through random sampling from the rest of the ranked R1 institutions in order to reduce selection bias and diversify representation. Although most schools appearing in the rankings hold R1 status, any institutions without R1 designation were excluded from consideration to maintain consistency in institutional research intensity across the sample.

After selecting institutions, we searched each school's library page to identify their engineering research guides. One institution did not use the LibGuides software and was excluded, bringing this study to a total of 49 institutions. For a two week period, from 7/30-8/13/2024 we took screenshots of every page and tab for each engineering LibGuides present per site. We used the Safari browser's "Export as PDF" feature which we found created the most true-to-the-original static version of each page. LibGuides has a feature that allows pages from other guides and external links to appear integrated. Any such links were excluded so that only pages created specifically for the engineering guide being analyzed were included. For example, a tabbed link to a separate guide on technical standards would be excluded, however, an entire page dedicated to standards that was part of the chemical engineering guide would be included.

After the initial data collection, all PDFs were imported into NVivo, which allows for organization, coding, analysis, and visualization of unstructured data. First, each file was coded by engineering discipline. At this stage, we made the decision to focus solely on chemical engineering guides. In this set we included guides that focused only on chemical engineering as well as multidisciplinary guides which explicitly included chemical engineering such as "chemical and biomolecular engineering." Several institutions included general engineering guides, which did not specifically cover chemical engineering and these were excluded. The reduced, final number of guides in our data set is 29. In order to maintain consistency throughout the process, we kept track of coding changes in a shared document. One file at a time, one of the two authors coded each PDF.

Figure 1 illustrates all of the primary coded variables. Resource access was recorded as a text string (title of the book, database, website, etc.). Pedagogy was coded as a proportional area of the entire PDF. A region was coded as "user centered" if the content was principally a collection of resources, with or without description, presented as a list or otherwise. For a region to be coded as "learner centered" it needed to be content aimed at teaching the viewer how to do or understand a concept or task. For example, content explaining what a technical standard is and the details of licensing around them would be coded as "learner centered," while a list of databases the institution's library subscribes to from which someone can download a standard would be coded as "user centered." While not always the case, some PDFs had different regions coded for each variable.

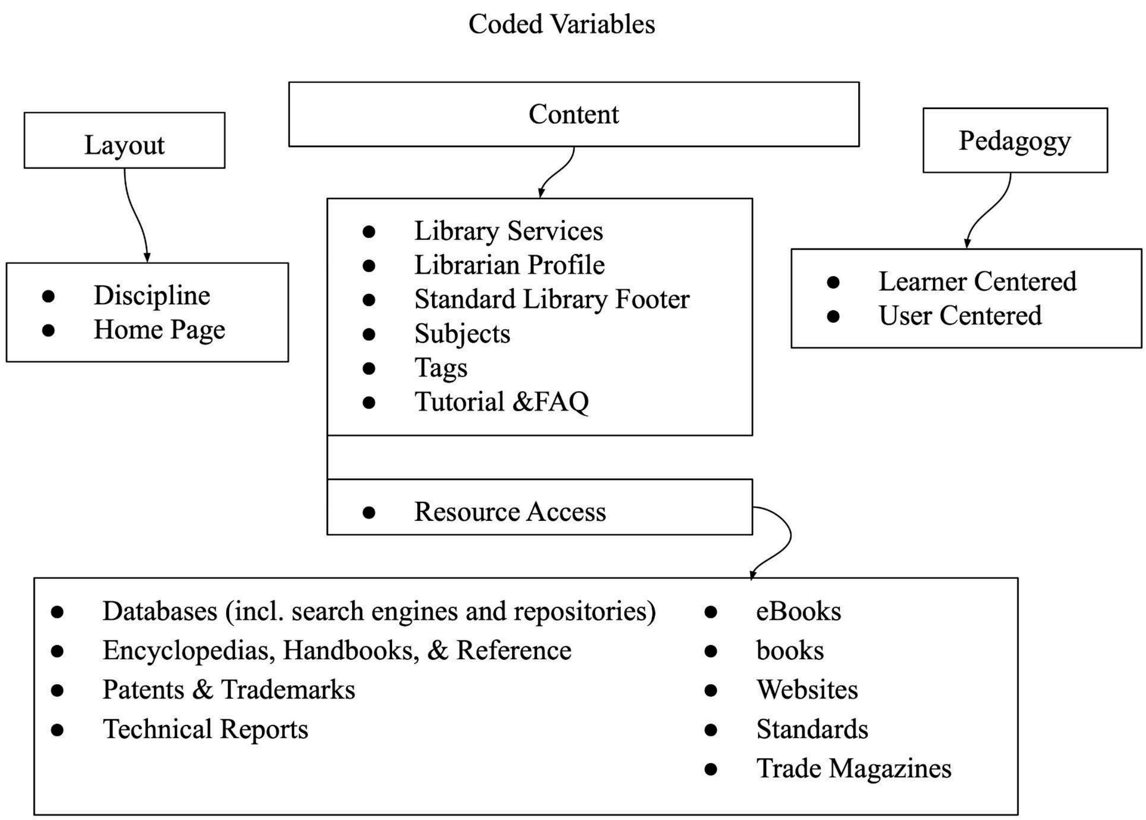

Fig. 1- Each PDF included in the data set was initially coded using variables to capture layout, content and pedagogy.

The data gathering and coding was done entirely by this paper's authors. To ensure as much consistency as possible, the authors independently coded and compared trial PDFs of engineering guides from institutions not included in our data set. We used the results of this trial to calibrate our individual understanding of the codes. While each PDF included in the data set was coded by only one of the researchers, frequent meetings as well as running documentation was kept in order to maintain as much consistency as possible across the coding process. During the coding phase it was sometimes found that codes needed to be added to the initial list. In addition, some of the variables initially created to be coded were found to be difficult to code consistently and these were dropped. Ultimately, we focused on coding under the resource access and pedagogy categories.

Data Cleaning and Analysis

NVivo is designed to facilitate detailed coding of unstructured data. This was a benefit during the coding process but worked against us, to an extent, during the data clean up and analysis phase, since no feature was available to easily extract the data into a spreadsheet. In order to work around this, NVivo's "generate report" tool was used to extract data into a text document that was then exported to an Excel spreadsheet. From here, we assigned institutions to each piece of extracted data in the spreadsheet. Data was clustered by institution, so this process, although time consuming, was manageable. In this format, the data was then further cleaned. The two major types of variables we ultimately analyzed were pedagogy and content, specifically "resource access."

We applied a comparative analysis using percentage based measures to the pedagogy data. The two variables in this category, "learner centered" and "user centered," are coded as regions in each PDF file. NVivo then converts these regions into a percentage of the entire area in the corresponding PDF. The values for each variable, per file, can be extracted for analysis. It is important to note, that in all files, areas such as the navigation tabs, headers, footers, librarian profiles and solitary blank spaces were not coded as either variable, so no single file would be coded at 100% with both pedagogy variables added together. The sum of the percentage values for each variable across all 29 files in the dataset was calculated and then compared.

The resource access data presented more challenges and considerations. To begin with, the names of resources needed to match for an accurate analysis. In many cases, although time consuming, cleaning the data for standardization was straightforward. It is likely, however, that some titles for identical items were different enough that they were not counted as the same resources. This seems especially likely for web pages because our analysis method was not able to take into account URLs. Another issue that came up was that some institutions recommended a resource multiple times within the same guide. In fact, some had the same resource recommended up to six times. We chose to count each resource only once per institution even if it was repeated multiple times, as to not skew results. This required removing duplicate entries per institution. Finally, some resources are hosted on different platforms and LibGuides might list either the hosting platform and/or the resource itself. The most common occurrence of this happened with the Engineering Village platform and databases such as Inspec, Knovel or Compendex. In these cases, if both were listed, then the individual databases were counted as the resource when cleaning the data. If only the platform (i.e. Engineering Village) was listed, then it was retained as the resource. In cases where there are different subscription tiers of a database, such as is the case with Academic Search which has Premier, Complete and Ultimate, they were counted as the same resource. The implications of these choices will be discussed in subsequent sections.

Results

Resource access yielded the most data within the content category. The frequency of the coded resource type categories as they appear, at least once, across institutions is illustrated in Figure 2.

Resource Type	**Number of guides**
Databases	29
Encyclopedias & Handbooks	28
Websites	27
Library Catalog	24
Patents & Trademarks	16
Books & eBooks	15
Journals	12
Standards	11
Other	11
Multimedia	9
Trade Magazines	9
Dissertations & Theses	7
Technical Reports	5

Fig. 2 - This table shows the frequency of resource types included across all guides in the data set.

Of every resource coded, the types that were most common on guides were databases, websites, reference (encyclopedias, handbooks and other reference works), and books (both print and electronic). Figure 3 illustrates the top most frequently occurring resources in each of these categories.

Fig. 3- Across guides, databases, websites and references were most commonly occurring. The graphs in this figure illustrate the most frequently occurring titles in each of these categories.

In the category of databases, SciFinder-n was referenced on 100% (29) of guides included in the data set. Knovel and Web of Science were also referenced frequently, on 83% (24) and 69% (20) of guides respectively. PubMed, Reaxys, Compendex and AccessEngineering were referenced on almost 50% (14-16) or more of the guides included in the dataset.

There was much less frequency of common websites across the dataset with NIST (the National Institute of Standards and Technology) occurring the most, on 28% (8) of guides. Of note, multiple individual NIST databases were present across guides, but not with enough frequency for any to make the top of the list of databases.

The four most common coded references in descending order are *Perry's Chemical Engineers' Handbook, Kirk-Othmer Encyclopedia of Chemical Technology*, *Ullmann's Encyclopedia of Industrial Chemistry*, and *CRC Handbook of Chemistry and Physics*, appearing on 55%-69% (16-20) of guides.

For pedagogy, 85% of the information presented on the guides coded was user centered and 15% was learner centered. The location of a more complete list of results can be found in the Supplemental Materials section.

Discussion

This study addresses its primary research questions by identifying patterns in content and pedagogical approach in chemical engineering LibGuides at R1institutions. Our analysis reveals some level of consistency in the types of resources presented, particularly databases and reference works. Tools such as SciFinder-n, Knovel, and a few major chemical engineering references appeared on a majority of guides, suggesting shared disciplinary norms among engineering librarians regarding core research resources.

At the same time, the results highlight limitations inherent in this type of analysis, particularly related to resource naming and standardization. For example, NIST resources appear frequently across guides but are likely undercounted because individual tools were referenced using distinct names or described at different levels of specificity. This issue is most pronounced for web-based resources, where variability in labeling reduces the reliability of frequency comparisons. Taking this into consideration, these findings should be interpreted as indicative of potential trends rather than precise measures of resource frequency. In addition, these kinds of limitations should be considered for subsequent analyses that may be undertaken, especially if these kinds of distinctions are considered central to the research question.

The apparent predominance of subscription-based resources could reflect a number of factors such as the bias of guide authors or institutional constraints. Many commonly cited databases and reference works need to be purchased or require licenses, and their inclusion may depend more on local access than on curatorial intent. Consequently, the absence of certain resources does not necessarily indicate their perceived lack of value by the guide authors. It is also possible that guide curators feel a responsibility to promote institutional subscription holdings over open access options. Systematic investigation of these potential influences falls beyond the scope of this study and represents an opportunity for future research.

Pedagogically, chemical engineering LibGuides were overwhelmingly user centered, with approximately 85% of content focused on directing users to resources and less than 15% providing instructional context. While this study does not evaluate best practices, the strong preference for user centered design suggests that most guides function primarily as pathfinder tools rather than as learning objects. It is not the authors' intent to make a case, either way, as to whether there should be more learner centered content in guides, however, these findings can provide a foundation for future discussions about the role of instruction in engineering research guide design.

Conclusion/Future Steps

This study provides a snapshot of current trends in the composition and pedagogical orientation of chemical engineering LibGuides at R1 research universities. By identifying commonly included resource types, frequently cited tools, and prevailing instructional approaches, the findings contribute to a small but growing body of literature on engineering research guides. These results may be useful for those looking to create or revise their own research guides to better align with current trends or make improvements to more common practices. The results do not establish best practices, however, they do offer a descriptive foundation that librarians can use to reflect on their own guide design decisions and to situate local practices within a broader disciplinary context.

Future studies could build on this work in several ways. A more narrowly defined scope may allow for deeper analysis and more nuanced conclusions. Establishing realistic goals aligned with the number of researchers involved would also improve efficiency, consistency, and reduce the need for post hoc methodological adjustments. Collaborative research involving a larger team could support more comprehensive analyses, including larger sample sizes, and cross-disciplinary comparisons.

The results of this study can serve as a starting point for more normative discussions about best practices in LibGuide design. LibGuides continue to function as both access tools and instructional artifacts. An understanding of the content and how it is presented on LibGuides is a critical step librarians can take towards shaping how these guides might be used more effectively in the future.

Supplemental Materials

More detailed data files, preregistration and other materials related to this study can be found on the associated OSF project page:

> S. Weiss and L. DiCiesare, "What's Guiding Chemical Engineering?: A LibGuide Content Analysis (Supplemental Materials)," Jun. 2024, doi: 10.17605/OSF.IO/KTEG7.

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