

Best Practices for Engineering Information Literacy Instruction: Perspectives of Academic Librarians

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Abstract

Information literacy instruction (ILI) has long been an important part of undergraduate education. Subject librarians, together with undergraduate instructors, help students identify the relevant information sources in their discipline and learn how to search for, locate, and recognize high-quality information effectively. Information needs, specific resources, and information practices differ across subjects and vary by workplace and discipline norms. This work, funded by the Engineering Information Foundation, presents our first step in developing a series of modules to support engineering students' development of information literacy. We have interviewed five engineering librarians at the 2018 ASEE annual conference to better understand the best practices for information literacy instruction in engineering courses. Based on the analysis of the interviews we identified and described a number of concepts that will be considered as we develop our modules. This paper also provides a list of recommendations for faculty and librarians who are involved in ILI for undergraduate engineering students.

Introduction

Information literacy instruction (ILI) has long been an important part of undergraduate education. Subject librarians, together with undergraduate instructors, help students identify the relevant information sources in their discipline and learn how to search for, locate, and recognize high-quality information effectively. Information needs, specific resources, and information practices differ across subjects and vary by workplace and discipline norms. Effective instruction considers these discipline variations as well as the needs of the instructors and students. This work, funded by the Engineering Information Foundation, presents our first step in developing a series of modules to support engineering students' development of information literacy. We have interviewed five engineering librarians to develop a list of best practices for information literacy instruction in engineering courses. Based on the analysis of the interviews we identified a number of concepts that will be considered as we develop our modules. Two of these concepts include the need for a strategic approach and the need to incorporate instruction throughout students'

undergraduate career. This paper also provides a list of recommendations for faculty and librarians who are involved in ILI for undergraduate engineering students.

Background Literature

ILI has been a focus since the 1970s, and there is a substantial body of literature on best overall practices [1-3]. AASL/AECT stressed the crucial role that these skills play in the process of learning, saying that “information literacy is [the] keystone of lifelong learning,” and adding that students “should have both information-gathering strategies and the critical thinking skills to select, discard, synthesize, and present information...to solve real-life problems” [4].

When it comes to the specific topic of information literacy instruction for undergraduate engineering students, the body of literature is more limited, but interest in academic research on the subject of incorporating literacy skills into undergraduate engineering education grew steadily, both among scholars and inside and outside the US, over the past decade. Students from different countries and backgrounds seem to be facing similar challenges, particularly in regards to distinguishing between credible and non-credible sources of information (Examples: European Union [5], Singapore [6], Malaysia [7], Canada [8], India [9], and Australia [10]).

Several older studies stressed that without incorporating proper information literacy training and instruction into the undergraduate curriculum, most students will lack these crucial skills [6, 11]. Recent studies have shown that increased availability of information resources on the Internet, and an over-reliance of the student population on easily accessible search engines such as Google, presents even more challenges [8]. With the extensive information readily available online, the lack of information literacy skills, and notably the inability of the students to distinguish between reliable and unreliable sources can not only negatively affect their chances for academic success, but also have an adverse effect of their future careers in engineering fields [12-14].

Major themes within the literature, discussed next, center on incorporating information literacy skills and training into engineering education, including the various traditional and non-traditional methods of teaching these skills, different techniques of assessment, the importance of building reliable and long-lasting relations with the faculty, and the use of new information technology.

A variety of specific instructional techniques used by librarians and faculty to deliver information literacy training are discussed in the literature, including “the traditional single-class instruction session, credit courses or parts of credit courses, workbooks, and handouts” [15]. Bryan and Karshmer [16] present empirical evidence that literacy skills of students are increasing significantly after exposure to single library sessions: “the library sessions [have] a significant positive effect on students' library skills in both the visual/experimental and non-visual/control groups.”

However, one-shot sessions have downsides, including short class time; inability to get in-depth into major-specific resources; inability to come back and focus on topics that are more difficult to the student than others; and lack of time to engage with individual students [17].

Better use of information technologies to teach information literacy skills seems to be a feasible option when it comes to the growing pressure of spending less time in the classroom but still effectively teaching ILI to students. Hanbidge et al. [18] proposed that while “inclusion of information literacy in undergraduate curricula often remains an aspiration rather than a fully realized ideal,” various forms of e-teaching (including mobile learning) can be an effective way to incorporate ILI into the undergraduate curriculum. Recent studies have highlighted online modules as a new tool that not only allows the teaching of information literacy skills, but also to assess the efficiency of the modules with pre- and post-tests [8]. The same study has shown better post-test results and higher attendance for online tutorials [8].

A number of active learning techniques have been recently highlighted as the key to success, including “flipping the classroom” [8], incorporating hands-on experience into the modules and tutorials [8], and using clickers to increase student engagement and learning [19].

Building a strong relationship with the faculty is seen as one of the critical elements in successful incorporation of ILI into university curriculum [11, 17, 20]. Massis [21] stressed that “the collaboration between faculty and librarians would “produce the most effective information literacy instruction, leading to a measurable level of academic fulfillment.” Building personal relationships with the faculty who teach engineering classes and tailoring ILI efforts to specific

courses is pointed out as the most effective strategy by several studies: “general advertising attempts to inform faculty about the expertise of librarians and the instructional services of the library have not worked terribly well. A more proactive and interpersonal marketing strategy is needed, with both departments and individual faculty members [11].”

Maynard [20] however, has pointed out that the attitudes of faculty members towards information literacy instruction are variable and inconsistent. Part of the problem is that while it is widely recognized that engineering students should have information literacy and research skills, there is no consensus on how ILI should be incorporated into the undergraduate curriculum [6]. While the Hanbidge et al. found an improvement in general acceptance of the value of ILI among the faculty [18], they also found there is still no explicit agreement between faculty and librarians about the right time and place to teach these skills.

Methods for Interviews

To get specific insights into best practices, five experienced engineering librarians were interviewed at the 2018 ASEE conference. These librarians all work at Carnegie Research One universities and have many years of instructional experience. Volunteers shared their expertise, instructional practices, and insights in face-to-face interviews lasting on average from 45 minutes to one hour each, using a semi-structured interview technique. (See Appendix for questions.) The interviews were considered an important addition to the information literacy instruction literature because most of the studies on this topic are case studies from a single university. While similar themes are reported in one study after the other, they are missing an in-depth perspective that we get from the interviews, where we asked librarians about different aspects of teaching information literacy skills.

Because of the subjective and reflexive nature of qualitative studies, ensuring trustworthiness and credibility throughout the qualitative research process of collecting and analyzing the data is essential. It is important for qualitative researchers to be mindful of and take steps to reduce possible biases. The research team that conducted this study took several measures to minimize or avoid, when possible, various types of biases.

Confirmation bias was addressed by gathering and analyzing qualitative data without preconceived notions of what the results of the study would be. We attempted to recruit participants with various backgrounds to investigate a range of experiences of librarians.

The semi-structured nature of the interview used in this study minimized pre-existing biases of the research team that crafted the questions. Open-ended questions were designed to let the participant lead the conversation and describe their own experiences, and the follow-up questions allowed to clarify the experiences described by each participant. A conventional content analysis approach was used to enable coding categories to be derived from the textual data generated [22]. In addition, data gathered by the interviewer was reviewed and analyzed by several members of the research team, ensuring that interpretation of the data was not over-reliant on the interviewer.

Results

Several major themes evolved from the interviews of experienced engineering librarians, whose excerpts follow in italics. Anonymous identifiers for the participants such as [I1] appear in brackets after the quotes. Main themes that we summarize in the conclusion are in bold.

Before turning to the themes, we would like to make two points. First, librarians said that all of the breadth of IL (Information Literacy) needs to be addressed in both ILI information sessions and in assignments. This point shows that librarians have a broad concept of information literacy.

"we are interested in assignments that would address the whole breadth of information literacy. Defining the problem all the way down to communicating the results... You try to create a lesson that, again, takes them across the whole scope. You want to give them the context. You want to make them understand the economics of this. You want to make them understand why a tool is useful. Ah, you want to talk about how to use it, the mechanics of using it of searching it and what do you do with that information once you have it. How do you cite it, or whatever it might be.[I4]"

Second, one librarian voiced his or her personal experience with lacking information literacy skills as an engineering student. This personal experience underscores the fact that librarians know why information literacy skills matter to their students.

“I’m an engineer... and I had no information skills until I went to library school, and so I know that this was missing in my own education, um, and so I value it for that reason.[14]”

Now, turning to the themes, many librarians stated that in order to successfully incorporate ILI into engineering curriculum, a **strategic approach** is needed:

“... 11 departments, that's 10,000 engineering students. Those poor librarians – how are you doing to work with 10,000 students? It's not possible! You have to take a strategic approach. So you have to meet with ... deans, associate deans, you have to know all of them. ...Every department had a director or a chair – you have to know them, which means you have to meet with them all at least once a year. Every department has an undergraduate curriculum person and a graduate curriculum person. You have to know them. Those roll in and out, so you have to stay on top of it. So you are going to meet all of them. And then the courses that you want to be integrated to, you have to meet and know the faculty.[14]”

An important element of the strategic approach is to use a top-down approach to explain the importance of ILI to University administration and to gain their support in further efforts:

“Start at the top; you sell this idea to the dean, the associate deans, each department chair, to the curriculum committee, to the accreditation people. Then you ...identify these courses, and you work with the faculty and build this in.[14]”

“I start with administrators because I really believe – I wasn't taught any of this, and most aren't, so you have to really teach them [faculty] why is this important. Why students need to know about the information. And you do this over time, and so you must go and talk to them a lot. I feel like having an administration in support is very, very important. I don't believe in the grassroots stuff: a lot of librarians do the grassroots, and a partnership here, a partnership there, but you cannot change a curriculum by grassroots means. You have to start from the top and work your way down and build in.[14]”

A second theme that arose was that every participant stressed **building a strong relationship with faculty**:

“All the research shows that the faculty and librarians working together is the key. And some of our colleges do say “you have to check with the librarian about your resources. And we want a lit

review, so go to the library and work on the lit review.” So that's very, very useful for students.[12]”

Additionally, participants also viewed it as important to set up a process of **incorporating ILI into undergraduate engineering curriculum** through developing competencies, reviewing engineering courses, working with syllabus committees, working with accreditation committees on campus, and tailoring ILI to specific classes, developing hands-on work appropriate for a particular course (with the help of faculty).

“So, we started this program, and we worked department by department and embedded assignments into core courses at each level.[14]”

Also, two themes concerning instruction emerged during the interviews. First, every participant stressed the importance of using **hands-on training** to make the skills relatable to other tasks that are normal for engineering students (giving hands-on assignments from the specific fields of study, i.e., mechanical engineering, nuclear engineering, etc.). Using active learning and working together with the students seemed to be the most effective teaching techniques.

“I think hands-on learning really with engineering students they don't respond well to being just talked to ... The active learning really works well in that environment ... So that really works much better. We've been doing that the last couple of years and its really worked well. The students have expressed a more positive response to it.[13]”

“We went to the active classroom about three or four years ago, and it makes all the difference in the world... And we have exercises to work with, to find this database, or to find this article, or I want this side of the classroom to go and do a general Google search or Google Scholar search and tell us what the results are. And then I will tell the other side of the class to go to another database. If they are primarily engineers, I always do this exercise. Every class I have. I will say I want you to use the engineering databases. Find good resources. Then I would break them into teams; we use that approach sometimes too. So, the active learning is all the difference in the world, they get hands-on, then can peek over each other's shoulders, they can work in teams, they can see how it works, and they can see the results.[12]”

A second theme concerning instruction that arose was that assignments have to be **course specific** and help the faculty in teaching what they already were planning on teaching:

"The second thing is to not make it something that is really time-intensive, to take as much of the workload off them [faculty members], to take it off their plate and to make the assignment something that is already happening in the course... when you go and sit down with a faculty member, the first thing you kind of talk about the idea, make sure they know what we're going for, but then you say, tell me about the class. What are the objectives of the course? What are the major assignments in the course? And then you say, "well would you be open to us creating an assignment that would fit?" ... So, often you can figure out what they are already doing, and you can just take it in a certain, you can just change it a little.[14]"

Participants also pointed out that in order to teach Information Literacy (IL) skills effectively, librarians and faculty should take into consideration the characteristics of the engineering mindset and academic experience. For example, Participant 5 said that he/she presents ILI skills as a toolset that can solve problems and has to be end-goal oriented. Several pointed out the effectiveness of using the same techniques that engineering students are already using in other school work (such as teamwork, being presented with a problem, and being asked to provide a solution):

"...teamwork. I always try to do activities as a team, because they [engineering students] are very often working in their teams anyway, so I try to keep them working in their teams in a research setting. I find that that works well. And then I also find that generally, it generates conversation much more than single assessments.[15]"

"Um, I mean there, engineers very practical people. They're very easy to please. Right, they, as long as the information is good enough, they don't worry too much beyond, they don't really question beyond that. Right? And some of the other disciplines like in chemistry there's more emphasis on you know, double checking that information, making sure it really is an authoritative source. And with engineering, they're just whatever works. Whatever meets that immediate need.[13]"

"I think all [engineering] students are very, very focused on the end product... That's why I think when you use an assignment the faculty member has put into the course, they know it has value. It's going to make sense to them. Students and engineers like to save time. They like tricks. Now you call it hacks. They like that. They like that. So, if you show them something, you know, that gives them some new insights, gives them a tool they can use. Enhances their productivity or just gives them some little bit of knowledge.[14]"

"Even if that was information, but the information they didn't have [before]. They value that kind of thing; they value just knowing more. They value having that context. They value anything that gives them a shortcut. They value if you explain to them what a \$100,000 database costs, they value having access to that. It's really easy to find something they value, but you've got to find something they value.[15]"

According to one of the participants, the best algorithm of working with students includes the following segments: what's the problem that needs to be solved? What are the best tools to solve that particular problem? What are the mechanics of the tools? How do you evaluate results?

"But in general, I always try to cover how to approach the problem, thinking about the problem, and if it's a small enough room, we'll do it together. Because you have an assignment, you have something concrete in your hand. So, you will be like "You! What's your topic? What are you doing? What are you thinking? What does that mean?" And it's their area. I'm not a chemical engineer. So, what does that mean, explain it to me, so I can understand that because I don't understand that yet, so we'll talk about it. Then we will discuss the tool – or tools that I want to show them, and then demonstrating that we are doing that together.[14]"

All of the participants stressed the importance of the faculty referring the students to librarians through the course as one of the best predictors of strong information skills, as well as faculty presenting the literacy skills taught by librarians as a skill critical not only for an academic career but for success in professional career:

"And often times I will use my own example as having been an engineer, but I'll talk about how when they get out there they are going to have to find information as part of their jobs, and they need to know about, they need to have a broad knowledge of the universe of information.[14]"

"Because it's not just research. It's beyond. Wherever they go in their careers if they can use that; if they can evaluate information.[15]"

Participants stressed the importance of **having access to students throughout their career in the university**: at the beginning of their career (usually with general information literacy sessions incorporated into the freshman classes) and at the senior level, when students have emerged into the discipline-specific class (with sessions focused on resources and skills that are discipline

specific). It is important to build the skills progressively, from very basic and general to more complex and discipline-specific, like standards or codes.

“Well, the first year’s a very general overview of, of the library and the types of services and information the library provides. Um, there’s some basic information about different information types, so textbooks versus handbooks versus journals... and then they are introduced to citation management. So, um we teach, for undergraduates we teach Zotero the citation management. Uh, so that’s basically all we cover in the first year. And then in the second year, we go a little deeper...[13]”

“... the way that is designed is that, um, in the first and second year, engineering courses, ah, there is a specific course that has information literacy in the first year and in the second year there is another course, um, that has a workshop style, um, session. The first year is all online tutorials that students kind of work their way through the online material. The second year there's a live hands-on activity. Ah, and in the third and fourth years, um, it's broken out by discipline, so I have a third-year chemical engineering technical communications course I see, and the fourth years there is an advanced research course that I also do a session for. Ah, that's sort of similar for other disciplines too so that the librarians that do mechanical, electrical, ah, geological engineering also kind of follow that same pattern.[13]”

One of the participants stressed that incorporating ILI into the engineering curriculum, done right through partnerships with faculty, as well as incorporating ILI into the various course at every year results in the changing of the culture:

“...somehow the culture changed. I don't know if the older [students] started telling, the younger ones, but I would always go to this sophomore core class, that has 90 students every semester and after about two years, they knew the name of Perry's Chemical Engineering Handbook, they didn't need me to tell them. I was like – how did you know? But somehow it changed. And I go to the seniors, and they are smart kids, and they knew about information in a way that a few years before they didn't.[15]”

The participants voiced several challenges that arose during providing information literacy instruction. One of the biggest challenges and problems that emerged is the inability of students to distinguish between "good" and "bad" online sources, both in terms of databases (Google vs.

engineering databases such as Engineering Village) and in terms of sources (academic vs. non-academic):

“And then I - because I'm flipping the classroom, and this just might be my own thing, but I have seen this with other undergraduate students in general, although I mainly interact with undergraduate engineering students - is that because now everything is online, they have real trouble differentiating what is Google and what is Engineering Village. Like it's just all online. So, what's a journal article? What's a book? What's a popular magazine article? Like, it all looks the same to them. So I tend to spend more time on those critical sources.[15]”

“Yeah, and we have a section on Google as well, just describe it as a black box of information... Yes, that helps them, to understand that Google might not be the best place to go.[15]”

In addition, there seemed to be additional issues related to working with adjunct faculty who often teach survey classes:

“And they are mostly – the faculty that teaches those students are mostly sessional or adjunct faculty, so they might not be there next year... It's tricky. It's very hard for me to find who is there, and to track down who will actually be teaching that course, and who is new, and they are coming in August, and sometimes even the end of August, so I'm like ok, it's hard. It's tricky. But it's challenging with that kind of sessional faculty, with that kind of sessional faculty that are here today and gone tomorrow.[15]”

Another interesting topic that came up is the growing number of international students in engineering majors/classes. While the skills taught to students from different national/language backgrounds are the same, there is a growing need to adjust teaching modules/lectures/exercises for international populations, especially in larger schools with an increasing number of international students (for example, include text to be read or subtitles into online modules). See [23]. Among other issues that are important to non-native English speaking engineering students enrolled in US universities, this study has pointed out language barriers, cross-cultural differences in higher education environments, and awareness of resources.

Conclusions and Recommendations for Information Literacy Instruction:

We now summarize from the interview results the main recommendations for information literacy instruction for undergraduate engineering students.

- ***A strategic approach***

As we mentioned in the results section, engineering librarian found it important to work with administrators to get information literacy instruction adopted by engineering departments.

"First thing again is the idea of working from the top down so that... they [the faculty] know that this is valued by their department chair and valued by their dean. Sort of selling it all the way down the line, so they see this is a good use of their time.[I4]"

- ***Building a strong relationship with the engineering faculty***

Some specific examples of ways to build a strong relationship with engineering faculty came up during the interviews. These examples illustrate the importance of this main theme:

Suggest to the faculty to give extra credit for working through the training modules outside of the classroom

Help with grading the IL assignments: *"... if there is grading that needs to be done: we actually created our own rubric with a faculty member at ***, and we created these little grading sheets to make it easy so we could either offer to grade ourselves or we could teach their TA how to grade or teach them how to grade it...[I4]"*

- ***Incorporate ILI into the curriculum***

Incorporating ILI into the curriculum was another major theme that arose in the results and also was approached strategically from the top-down by librarians.

Use a top-down approach: *"...to sell the idea that information skills needed to be embedded in the engineering curriculum and that we had defined the competencies, and that competencies came from ****.[I4]"*

- ***Hands-on training***

Hands-on training was seen as important by all the participants and could incorporate active learning, and pre- and post-testing.

Use active learning, work with the students on assignments in class

Use pre-testing to determine what is needed: *"So we pre-test and post-tests, to determine what they know in the pre-tests, and then they go through each of the five modules that are general quality criteria, the credibility of your resources, then is a module on that than there is a module on a search logic, how to [inaudible] your keywords together. There is a module on databases,*

what are the good quality ones that you can use, and then there is a question in the module about research in general, peer review and that kind of thing, introduction to good research at the university level. And then we do post-test as well, so can determine if there is any movement between pre-test and post-test.[I2]”

- ***Course-specific teaching***

All participants stressed the importance for developing instruction relevant to particular courses and including language and concepts familiar to engineers.

Create assignments for specific courses and get the faculty interested in it

Work with faculty to find out what assignments are already used in the class and how you can tweak them a little to fit ILI: *“For example, if faculty gives them data, why don’t we make them find it? [I4]”*

Present IL skills are tools that help solve specific problems, use language that is familiar to engineers. Use Algorithm: the problem – the tool – evaluating the results – communicating

Talk about mechanisms of things, specifically databases

- ***Teaching ILI throughout students’ entire career***

Access to students throughout their academic career was also viewed as important to all the participants.

Embed the ILI into core classes at each year: *“So, we started this program, and we worked department by department and embedded assignments into core courses at each level. Um, we tried very hard at the freshman level, but that was just very hard you know. It ended up being very introductory but getting an assignment in a core course at the sophomore level and junior level and senior level, and usually at the senior capstone course.[I4]”*

Build up IL skills gradually from more generic skills to more discipline-specific by senior year

Future Steps

Some of the results from the five interviews are informing the creation of information literacy modules for freshman engineers and students in a senior engineering design class. These modules will incorporate advice from the interviews of teaching ILI throughout students' careers, as both freshmen and seniors will be the audience of the video modules. Also, the videos build on the idea of having a strong relationship with faculty as two engineering faculty members created the videos for the freshman class (and are co-authors on this paper). Similarly, a strong librarian-faculty relationship with the faculty member teaching the senior level class has allowed introduction of the advanced videos in the design class. The videos also have an active learning component, as students are asked to complete activities after viewing them (either taking a quiz or completing a reflection exercise).

We believe that insights from the interviews could inform other librarians' information literacy instruction, as well. We will continue refining the video modules in our project through collecting student feedback.

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Appendix

Interview Questions

	Base Question	Sample Follow-up Questions
1	What is your role at your university?	
2	How are you incorporating information literacy training into undergraduate education curriculum in your university?	Do you work with other faculty members on incorporating information literacy training into their classes?
		What kind of support do you offer to students in enhancing their information literacy skills?
		What are the specific classes that you incorporate information literacy training into?

4	What have you found to be the most effective way of teaching information literacy to undergraduate engineering students?	
5	What kind of hand-out materials do you use?	
6	Do you incorporate hands-on activities into your information literacy training?	What assignments do you find to be most useful?
		What kinds of modules do you use?
6	Is your training conducted in-person or online?	
7	What resources do you include into your training sessions?	What databases do you recommend to your students?
		Why are you recommending these databases?
8	Do you volunteer to do these kinds of trainings or are you asked/required to?	
9	What kind of educational materials focused on literacy skills for engineering students are available at your university?	
10	How do you evaluate the effectiveness of your information literacy training?	