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Information Literacy Modules for First-Year Engineering Students

COURTNEY FABER
Stoneking Engage Engineering Fundamentals Program
University of Tennessee Knoxville

RACHEL ELLESTAD
Stoneking Engage Engineering Fundamentals Program
University of Tennessee Knoxville

ALEXIS WALSH
Industrial and Systems Engineering
University of Tennessee Knoxville

URLs to videos:

Module 1 Video: Information (https://youtu.be/jj5TvfhDfp4)

Module 2 Video: Assessing Information (https://youtu.be/4C0A3aHEyUw)

ABSTRACT

The abundance of information available to us every day continues to increase, largely because of society's reliance on the internet. While the internet provides access to a wealth of information, information may be inaccurate or irrelevant because anyone can publish content on the internet. As a result, it is critical for individuals to develop information literacy, which includes the skills to gather information, assess its quality, and use it effectively. Information literacy is especially important for engineers because of the need to be lifelong learners in order to adapt to the needs of society and technological innovations. Despite the importance of information literacy, it largely remains absent from undergraduate engineering curriculum. In this work, we developed two modules that were implemented and assessed at two time points in two different first-year engineering courses. These modules focus on defining information and providing a framework to assess the information. Each module includes a short video followed by a handout with questions designed to support students in making connections between the videos and their assigned design project. The development of the modules was informed by current research within the area of information literacy as well as the first two authors' experience teaching first-year engineering students. Assessment data from the two implementations show that students were able to identify a range of resources they used to get information for their design project. While some students were able to assess the quality of information using a structured process, many students' assessments were superficial and needed more time and instruction to improve. In addition to discussing our assessment outcomes, we provide a reflection on our personal experience implementing the modules to support the implementation of these modules by other instructors. These modules are available for use, testing, and adaptation in other first-year engineering contexts.

Key words: information literacy, first-year curriculum, assessment

INTRODUCTION

Access to an abundance of information is ever increasing due, in large part, to society's continuing reliance on and connection to the internet. Current higher education students fall into the Generation Z category, or what is known as iGen. Members of iGen are more connected and have easier access to information than any generation prior because of the internet. Though access to the internet provides a wealth of opportunity and resources, it also allows free access to potentially irresponsible actors who produce content with little thought about accuracy or relevance (Farber 1994). This lack of quality control requires users of the internet to play a more active role in determining quality and relevance. There is significant concern that current higher education students have limited skills in being able to locate information, assess its quality, and apply information appropriately to support an argument (Leckie and Fullerton 1999). These skills, known as information literacy skills, are critical in disciplinary learning to prepare students for future careers.

Information literacy is generally defined as 1) the ability to recognize when information is needed to support a body of work and 2) the skills needed to gather information, assess its quality, and use the information effectively to support the argument being made (Feldmann and Feldmann 2000; Messer, Kelly, and Poirier 2005). Feldmann and Feldmann (2000) note a number of different skills and abilities associated with information-literate individuals, including the ability to determine that information is needed, effectively access different sources of information, evaluate the quality of information, and use information appropriately in a specific context. Information literacy is especially critical in the engineering profession, where practitioners must demonstrate an ability to be life-long learners in order to learn about emerging societal problems and emerging technologies. A survey of practicing chemical engineers showed a significant amount of time engaged in information gathering and use on a daily basis (Leckie & Fullerton, 1999).

Engineering and science faculty recognize the importance of information literacy skills among their students (Leckie and Fullerton 1999). Even so, many faculty do not actively engage students in developing information literacy skills or do not know about resources available to them for helping students gain information literacy skills in their own courses (Leckie & Fullerton, 1999). In fact, many engineering and science students are not engaged in the use of literature sources beyond their course texts until their senior year or into graduate work. Wilkes, Godwin, and Gurney (2015) found that, though faculty recognize the importance of information literacy, engineering librarians tend to have difficulty gaining buy-in from faculty and staff on integrating information literacy learning into their coursework. Due to the important nature of these professional skills, faculty and staff should be encouraged to find ways of integrating instruction around these skills early in the undergraduate engineering curriculum.

First-year engineering programs tend to be 'all-inclusive' programs where students are taught foundational skills necessary to be successful in disciplinary study and the engineering profession. First-year engineering programs may focus on different themes, including engineering design, global interest, an introduction to the engineering profession, or the development of professional skills (Reid, Reeping, and Spingola 2018). Information literacy skills are integral to many of these focus areas. Previous research has shown that first-year engineering students have low level skills related to information literacy. A study conducted by Wertz et al. (2013) showed that first-year engineering students tend to use low-quality web-related resources (blogs, websites, FAQs) that are irrelevant in context when attempting to support arguments made in design related work. Zhang, Goodman, and Xie (2015) noted that many students face information overload in their first-year engineering programs, which causes further difficulty in learning skills that are decontextualized. They suggest that training in professional skills such as information literacy needs to be embedded into engineering curricula to provide context and meaning for students (Zhang, Goodman, and Xie 2015), which aligns with suggestions by Leckie & Fullerton (1999) to develop discipline specific information literacy training.

Purpose of This Work

The purpose of this work was to develop a series of video modules and activities that can be incorporated into courses to support first-year engineering students' learning about engineering literacy practices. Previous work on developing engineering literacy curriculums has focused on developing institutionally-context specific training (e.g., (Repanovici, Barbu, and Cristea 2008; Williams, Blowers, and Goldberg 2004; Nerz and Bullard 2006; Aydelott 2007)). The work outlined in this manuscript documents modules developed within an engineering context. These modules are not institutionally specific so they can be useful and translatable to other institutional contexts. In this work, we provide a description of the two modules developed as well as a summary of assessment data collected from students' application of the module content to their current class project.

The module development was part of a larger study, funded by the Engineering Information Foundation (Williamson et al. 2019; Kaufman, Tenopir, and Christian 2019; Tenopir, Christian, and Kaufman 2019). The overall project sought to understand current practices used to educate engineering students about information literacy practices by surveying online artifacts and interviewing engineering librarians in order to effectively design a series of modules to support the development of information literacy in the engineering disciplines. Interviews with five experienced engineering librarians resulted in the development of six themes around information literacy instruction in engineering: taking a strategic approach, building a strong relationship with faculty, incorporating information literacy instruction into engineering education curriculum, including hands-on training, making instruction course specific, and having students engage in information literacy instruction throughout their undergraduate career.

Along with the outcomes of the engineering librarian study, we used our expertise in first-year engineering education to inform appropriate topics for teaching information literacy in a first-year program. Dr. Ellestad and Dr. Faber are both engineering instructors who teach first-year engineering courses focused on introducing engineering physics as well as engineering professional skills through design-oriented projects. At the time of module development, they had five years and two years of experience teaching first-year engineering students, respectively. Over the years, they have observed how students use information for design projects in their courses. This experience has provided them with a general understanding of the needs of their students as it relates to information literacy and how to support their students in further developing and applying information literacy skills to first-year design projects. Combining the outcomes from the engineering librarians' study along with our own first-year engineering education knowledge, we developed modules focused on identifying sources and assessing the quality of information specifically as it relates to an engineering design project in the classes. While these modules are assignment-specific, they can be easily adapted to other classes and assignments within the area of engineering design.

DESCRIPTION OF THE MODULES

Each module included a short video (approximately five minutes) and a class activity of reflective questions for group discussion. We wanted the modules to be versatile so that other instructors could incorporate them into their classes, so we designed the videos to be general (ie. not specific to our courses). The videos were made as screencasts with images and a voice over. Based on the themes from the interviews, we knew that it would also be important for the modules to be specific to the students' course. To accommodate this goal alongside the goal of versatility, we developed the reflection questions in such a way that small revisions could make them specific to a range of design projects. We decided to develop two modules for first-year design projects with the first one focused on defining information and the second focused on assessing information, so that we could address multiple themes, from the engineering librarian study, in a format that would be manageable for students.

Module 1: What is Information?

The first module included a four-minute video followed by a class discussion that aimed to 1) define knowledge, information, and data, 2) discuss the types of information we are exposed to on a daily basis - both intentionally and unintentionally, and 3) prompt students to reflect on how information influences them as engineering students. The video began by providing a structure for understanding the difference and interconnection between data, information, and knowledge (Figure 1). The definition of and distinction between the concepts of data, information, and knowledge is a foundational building block in the discipline of information sciences (Zins 2007). Thus, a foundational knowledge in information literacy must start with an understanding of and distinction between these concepts.

To help students better understand these concepts and their relationships, data, information, and knowledge were each defined in the context of manufacturing donuts. This context was selected because it provides both an engineering context (manufacturing) and fun context to get listeners engaged. The donut manufacturing context provided an “inquiry-like” approach in which the students (listeners) are told that they show up for their first day at an internship at a manufacturing facility but do not know what the company makes. To illustrate the definition of data (facts or characteristics about something that by themselves has no meaning), the students were told that

Figure 1. Organizational graphic used to show the relationship between data, information, and knowledge.

Figure 2. Screenshot from Module 1 video showing the illustrations used to define data.

they see storage bins on their left with flour, yeast, and sugar and storage tanks on their right with milk, butter, and eggs (Figure 2). At this point, they were not provided any additional context about how much or how these ingredients were used.

Next, the students are told that they walk further into the plant and see a recipe called "Super Secret Donut Recipe" posted on the wall. This recipe included the quantities of the ingredients, which was used to model the definition of information (a form or organization that provides an answer to a question) (Figure 3). The video provides further details to help students understand why the recipe would be considered information rather than data.

Finally, the students were told that they notice a whiteboard with instructions on how long to cook and how to process the donuts. These instructions on the whiteboard were written by the operators based on their personal experience making the donuts. This third example was used to illustrate the definition of knowledge: an understanding that is acquired through experience or learning (Figure 4).

After defining data, information, and knowledge, the video discussed multiple locations where we interact with information on a daily basis, which included both the intentional interaction with information (ie. looking at information for a yelp review) and unintentionally interaction (ex. interacting with advertisements to learn about a product). We know that unintentional exposure to forms of information (e.g., subliminal messaging, cultural exposure) can impact behaviors and actions without awareness or realization of the impact of the information (O'Donohoe and Fanning 2013;

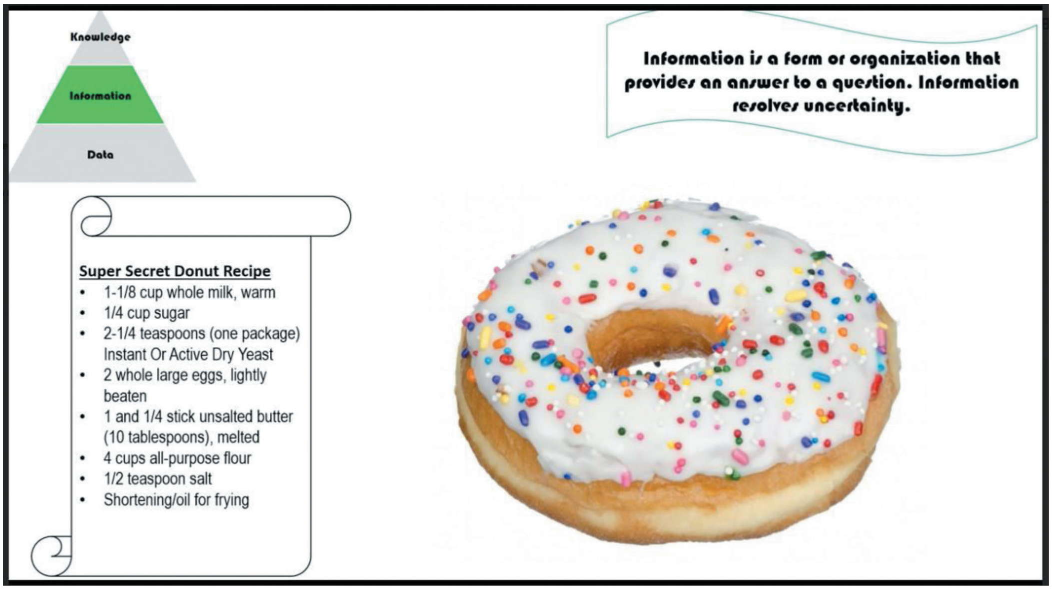

Figure 3. Screenshot from Module 1 video showing illustrations used to define information.

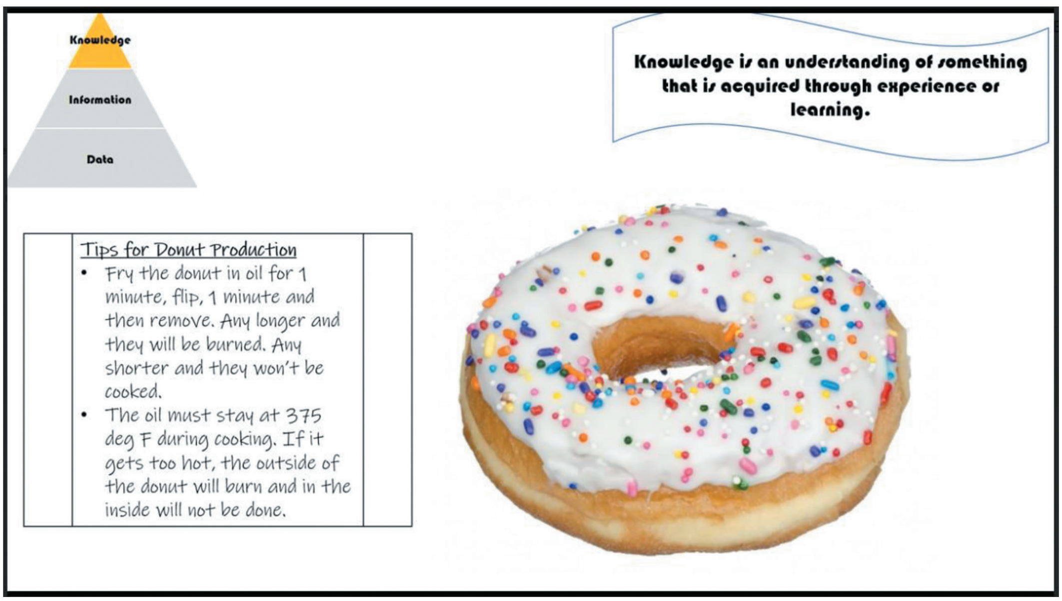

Figure 4. Screenshot from Module 1 video showing illustrations used to define knowledge.

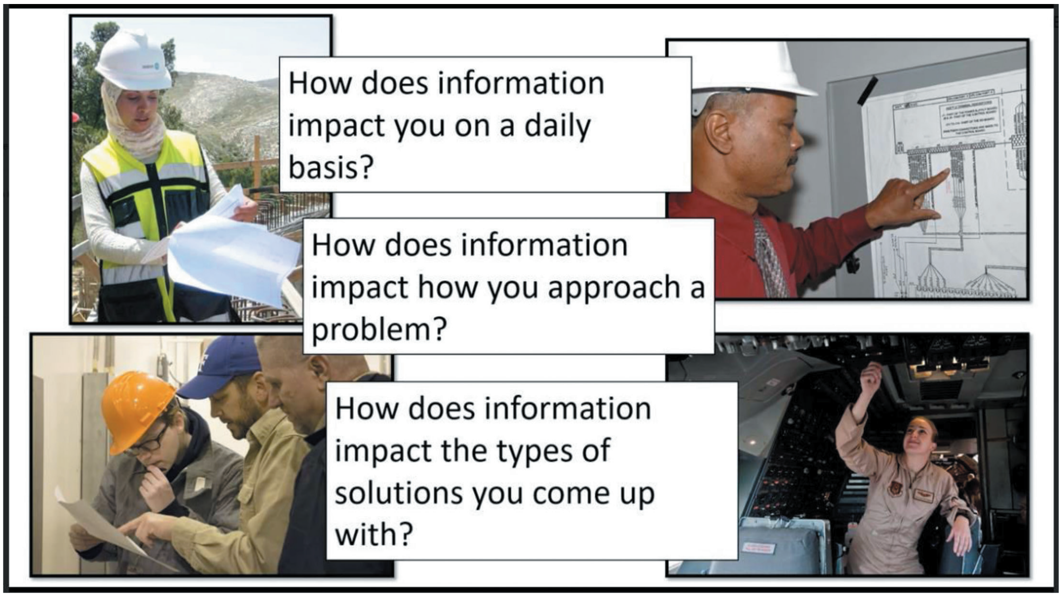

Figure 5. Screenshot from Module 1 video showing images of engineers in various work context and the questions for students to consider after watching the video.

Bargh and Morsella 2008; Vlassova, Donkin, and Pearson 2014). Our goal in approaching this topic was to engage students in thinking about how their design decisions might be influenced by both the intentional reflection on sources of information they seek out and the unintentional exposure to information in their everyday lives.

In order to connect information to the engineering profession, the video ended with a brief discussion of how and why engineers need to use information. Students (listeners) were then left with three questions to reflect on: 1) how does information impact you on a daily basis?, 2) how does information impact how you approach solving a problem?, and 3) how does information impact the types of solutions you develop? (Figure 5).

Following the video, the students were given a handout to complete with their project team. The handout (see Appendix 1) prompted students to think about and discuss information they are intentionally and unintentionally exposed to in the context of their class design project. After students discussed these questions within their teams, the instructor facilitated a whole class discussion focused on the two questions: 1) What types of information are you intentionally using to help with your current design project and 2) What types of information are you being exposed to (or have been exposed to) unintentionally that may be impacting your design decisions? These two questions could easily be rewritten for a different context - other than a team design project.

Module 2: Assessing Information

The second module focused on assessing information and provided students with an approach that can be used to assess the information they come across, known as the CRAAP test (Blakeslee, 2004). There are a variety of approaches that are taught by librarians to assess the credibility of information (see Hilligoss & Rieh, 2008 for a brief review and discussion). For this work, we decided to focus on approaches that have been designed to evaluate the credibility of online information, since that is the largest percent of information the students use for their design projects. We conducted an online search of approaches to evaluate information using a combination of Google and Google Scholar and found that many university libraries teach the CRAAP test (Blakeslee, 2004; Myhre, 2012). Reviewing the literature in library sciences on the CRAAP test, we found that many librarians teach this approach because of the easy to remember acronym (Blakeslee, 2004; Myhre, 2012) and alignment with other checklist approaches such as Kapoun (1998). The checklist approaches have been found to be helpful for students who are new to research (Wichowski & Kohl, 2013). We decided to focus our second video on using the CRAAP test to evaluate information, because of its memorable acronym, checklist approach, and appropriateness to evaluate websites.

Like the first module, this module included a short video (six minutes) followed by fifteen minutes for group discussion. The video started by describing that because we encounter a vast array of information every day from a variety of sources that it is important for us to have strategies to process the information (Figure 6).

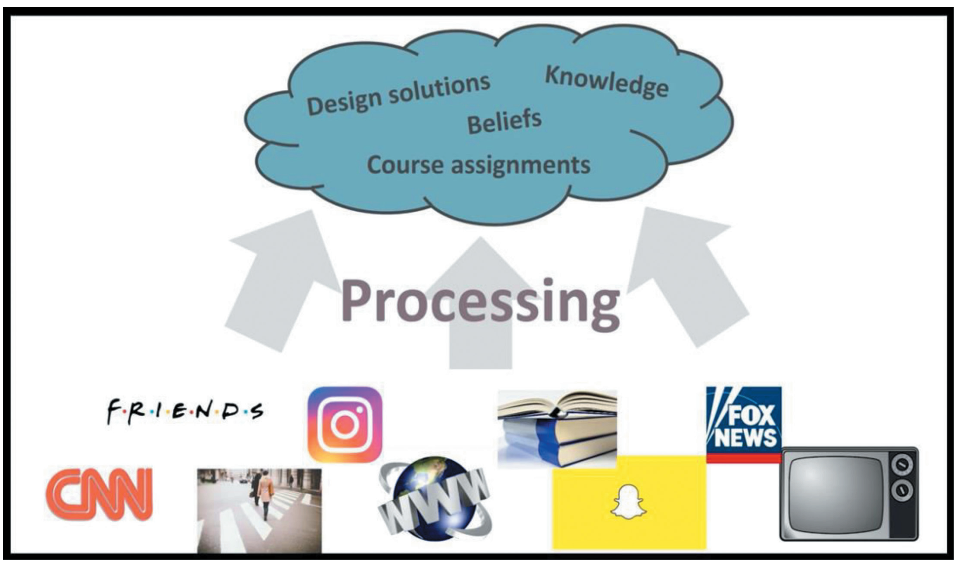

Figure 6. Screenshot from Module 2 video showing the illustration used to define the links between information we encounter and processing that information for a variety of purposes.

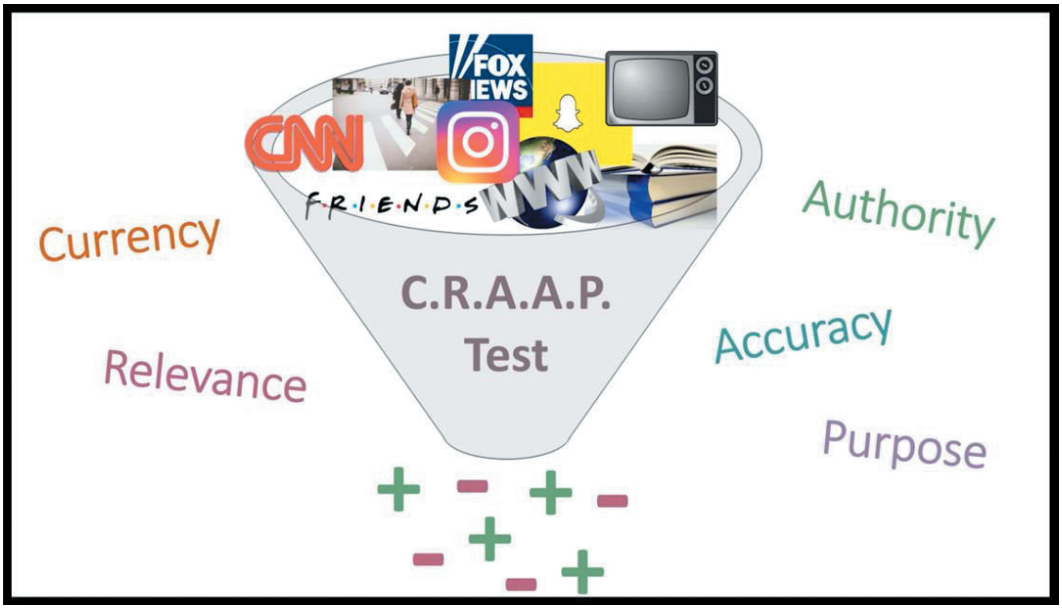

Figure 7. Screenshot from the Module 2 video showing the illustration used to define the five components of the CRAAP test and describe how it can be used to assess various types of information.

Then the video discussed that when we evaluate information it is important to consider its relevance and trustworthiness. This video focused on the CRAAP test (Blakessee, 2004), explaining that this test provides a general framework of five criteria that can be used to assess different types of information. Each of the criteria (currency, relevance, authority, accuracy, and purpose) were defined and described, providing examples relevant to different types of information (Figure 7). Furthermore, it was explained that the importance of each of these criteria will depend on the goal of and information being assessed. As such, not all of the criteria will be relevant for all types of information.

The rest of the video focused on defining and providing a set of questions for each of the five criteria that can be used to evaluate information (Table 1).

The video ended by posing three general reflection questions aimed at encouraging students to be more cognizant and critical of the information they are using to form their knowledge, beliefs, and support work in assignments. The three questions are: 1) when are you skeptical of information, 2) are there types of information you readily accept without question, and 3) are there people or positions that you trust everything they say.

Table 1. Action and example question associated with each criteria of the CRAAP test.

Criteria	Action/Definition	Example Question
Currency	Assess the timeliness of the information	Has the information been revised or updated?
Relevance	Determine the importance of the information for your needs	Does the information apply to your topic?
Authority	Assess whether the author has appropriate qualifications to publish the information	Who is the author/publisher/source/sponsor? What are the author's credentials or organizational affiliations?
Accuracy	Assess the reliability, truthfulness, and correctness of the content	Is the information supported by evidence?
Purpose	Think about why the information is being presented (teach, sell, entertain, inform, or persuade)	Who is the intended audience? What is the purpose of the information?

After the video, teams were given 15 minutes to discuss the following questions with their team (see Appendix 1 for actual handout):

- Of the types of information you defined yesterday, how did you determine what information to use for your design vs. what information to discard or ignore?
- How could you use the CRAAP Test to help you think about information for your design project moving forward? (table for response with each of the 5 criteria on a separate row)

FIRST IMPLEMENTATION OF MODULES

Modules 1 and 2 were implemented in a first semester introduction to engineering course at a large research institution in the southeast. As part of this course, students complete a five-week team design project. For this project, teams design a 3D printed life-hack to help a member of the amputee community do an everyday task. Specifically, teams had to provide the 3D printed solution, a video demonstration of their device, and a brochure providing an overview of the problem and their solution. Modules 1 and 2 were completed in a single class period (75 minutes) in a small lab setting facilitated by graduate teaching assistants during week two of the project to ensure that teams had started gathering information for their project.

Assessment Methods

For our assessment of the modules, we collected project teams' written responses to the questions on the handout (see Appendix 1). These assessment handouts served teams as a scaffolding to apply the information from the module to their current project and provided data for evaluators' analysis of efficacy of the modules to elicit the desired information literacy skills. Since these handouts were completed by project teams, we had to ensure that each member of the team consented to allow their responses to be included in our study prior to assessing their responses.

The class where the modules were implemented had a total enrollment of 183 students. In total, 32 teams with 112 students consented to be part of the study. The teams ranged from 2 to 4 students. Students represented all engineering majors in the college. No demographic or background information was collected on these students. As such, student demographics were not considered in our analysis. Our assessment methods were approved by our Institutional Review Board.

The handout for each module (see Appendix 1) was provided to teams of students after they watched the corresponding video. For Module 1, we wanted students to think about the types of information they were using to inform their project design. Specifically, we wanted students to think about intentional and unintentional information. As our team project focused on a specific customer base (members of the amputee community) we wanted to think about both information sources they were seeking to inform their project as well as information sources they may bring to the team due to prior experiences or biases. For Module 2, we wanted students to begin to reflect on the quality of information sources they were using to inform their project design. Using the CRAAP test as a model, we wanted students to use the CRAAP test as one structured method to evaluate the sources of information they generated in the previous lesson. The teams were given 15 minutes to discuss the reflection questions together and write their responses in relation to their life-hack design project. Following the time for each team discussion, the graduate teaching assistant facilitated a whole class discussion. Students' ability to apply the guidance from the modules was not evaluated as part of this assessment.

To analyze the team's responses to the reflection questions, we split the team responses in half so that each evaluator (Drs. Ellestad and Faber) analyzed 16 sets of responses. Each evaluator reviewed the responses for one question for ten minutes and developed a set of categories inductively to represent the responses to one question. Next, both evaluators came together and shared the categories from their response set. Both evaluators discussed common categories among both sets. The evaluators also questioned and challenged to determine if unique categories should be combined or represented unique responses in their set. After coming to consensus on the categories for a question, the process was repeated until all questions had been reviewed.

Assessment Outcomes

The types of information teams identified in the Module 1 activity focused on the types of information they were intentionally using and spanned four categories: 1) information about the task or artifact, 2) information about client, 3) information about project requirements and constraints, and 4) information about engineering tools. Information about the task focused on how to perform the task the teams aimed to design a life-hack for while information about the artifact included dimensions and specifications about the object or objects involved in the task. For example, this included the type and size of a necklace clasp for a team focused on developing a life-hack around putting on a necklace. Teams also reported needing information about who they were designing for or their client. This information included their limits and details about their lifestyle as well as trying to gain an emotional understanding of the individual's life. As the project was a course assignment, teams also listed needing information about the project requirements, such as the submission file size, 3D printing requirements, time constraints, and material constraints. Along these same lines, teams also described a need to have information about specific engineering tools that were needed for the project like 3D printing and modeling and the design process. Teams reported gathering this information from a variety of sources including the course website, course instructors, past experience, trial and error, the internet, and watching videos.

Question two for Module 1 asked students to think about the types of information they might be unintentionally using. Based on student responses it was clear that some students did not have a clear understanding of the difference between intentional and unintentional exposure/use of information. These teams reported that they were unintentionally using information such as project management tools (which were specifically assigned to the class), design constraints, and client needs. We would hope that students were intentionally using the design constraints and client needs as information to influence their design since this consideration was required to adequately complete the project. In contrast, many teams showed a clear understanding of the different types of information that might be unintentionally influencing their designs. This information includes project constraints (e.g. time limitations), other groups sharing their ideas, student workers providing input on team designs, their own past experiences (e.g. hobbies, classes, and two hand bias while working on a project for a person with one working hand), and likes and preferences.

The Module 2 questions aimed to have teams reflect on why they decided to use or not use information and think about how they could use the CRAAP test as they continue working on their project. After assessing teams' responses to these questions, it was clear that the prompts were not appropriately designed to facilitate the reflection we hoped. Teams focused on applying the CRAAP test to their design solutions rather than the information they used to inform their design decisions.

Revisions Based on First Implementation

To better prompt teams to apply the CRAAP test to the information they were collecting and consider which aspects of the CRAAP test were most relevant to that type of information, we made significant changes to the second prompt for Module 2. First, we specifically defined that we wanted teams to think about three types of information that their team plans to collect. Then we asked teams to describe how they will use each element of the CRAAP test to assess these three types of information. To support teams' reflection, we provided an example in the table (see Appendix 2). For this second implementation, we decided to revise our prompt related to the CRAAP test rather than finding a new approach, because it was clear to us that the students did not understand what part of their project they should apply the test to, since many of them used it to evaluate their final design solution. As a result, our edits to this prompt focused on clarifying that they should apply the CRAAP test to the information they were collecting to inform their final solution.

SECOND IMPLEMENTATION OF MODULES

The second implementation of the modules occurred a year after the first implementation within a second-semester first-year honors introduction to engineering course at a large research institution in the southeast. As part of this course, students complete a 10-week team design project where they identify a need within their local community that is related to one of the Engineering Grand Challenges and develop a solution. The teams work through a number of required stages focused on key steps in the engineering design process. To complete these stages, there was in-class instruction and specific assignments that were completed as a team. The needs that students identify are typically related to the team members' experiences, because one of the stages that teams work through requires them to develop a "bug list" or list of things that bother them as they go through a typical week.

The two modules were implemented as students moved into the concept selection stage of their project, which required research and development of possible solutions. Like with the first implementation, Modules 1 and 2 were completed in a single class period (75 minutes) in a small lab setting facilitated by graduate or undergraduate teaching assistants. Unfortunately, these modules could not take up the entire class period, because we had to spend the first 30 minutes of class discussing the transition of the course to online instruction due to the COVID-19 pandemic. As a result, many of the teams were not able to complete all of the reflection questions associated with Module 2. For this second implementation, we updated the second Module 2 question as described above. We also rephrased the other reflection questions to better align with the design project in this second-semester course (see Appendix 2 for the implementation two handout).

Assessment Methods

For our assessment of the modules, we collected project teams' written responses to the questions on the handout (see Appendix 2). Since these handouts were completed by project teams, we had to ensure that each member of the team consented to allow their responses to be included in our study prior to assessing their responses. The class where the modules were implemented had a total enrollment of 136 students. In total, 23 teams with 88 students consented to be part of the study. The teams ranged from 3 to 4 students. Students represented all engineering majors in the college. No demographic or background information was collected about these students.

Like with the first implementation, the handout for each module (see Appendix 2) was provided to teams of students after they watched the corresponding video. The teams were given 15 minutes to discuss the reflection questions together and write their responses in relation to their lifehack design project. Following the time for each team discussion, the graduate teaching assistant facilitated a whole class discussion.

To analyze the team's responses to the reflection questions, one evaluator (Alexis Walsh) conducted a question-by-question analysis to develop categories of responses. She started by reading through all of the responses to gain a general understanding of the responses, making a mental note of possible categories. Then, starting with question one, she reread the responses to that question and underlined like-answers in the same colored pencil, making a key as she went (e.g. the response "survey" was always underlined by a pink pencil). She went through the responses for a single question multiple times to make sure the phrases were in the appropriate categories, sometimes altering the categories if they were overlapping or needed separating. Throughout this process, she made notes of any responses that she was unsure about and questions about categories so that she could discuss them with a second evaluator (Dr. Faber). This process was repeated for each question. After the initial categories were developed by evaluator Walsh, she discussed these categories with Dr. Faber, who asked questions and compared to results from the previous round of assessment analysis. Since it was the second implementation of the modules, we will report a more detailed assessment of the students' responses compared to what we reported for our first implementation.

Assessment Outcomes

Teams reported intentionally using (Module 1 Question 1) a variety of different sources of information as they began to develop design solutions (see Table 2). The sources of information in Table 2 vary in their level of specificity, with some of the categories being subsets of larger categories. This occurrence is an artifact of the detail provided in teams' responses. In order to capture as much detail as possible, we chose not to collapse smaller more specific sources of information into the more general categories. For example, some teams reported using specific university websites or forums such as Reddit to collect information, while other teams reported looking up information online. While both university websites and online forums can be considered research on the internet, collapsing these two specific categories into the more general category would have removed some

Table 2. Categories identified from assessment of Module 1 Question 1 responses, focused on the types of information students are intentionally using for their design project.

Category	Number of teams
Research on the internet	10
Personal experiences/observations	11
Surveys	15
Interviews	9
Online forums/Reddit	2
News/newspaper	3
General research (not specified online or not)	11
University-specific resources	4
Other/current methods used	5

level of detail in the responses we collected. Likewise, some teams reported that they conducted research but did not specifically describe what research they did. For these cases, we categorized the team's response as "general research". Only responses that included terms such as "online", "website", etc. were included in the "Research on the internet" category.

A few teams used the term "in-person account" to describe the information they intentionally used. Like the term research, this term is vague and could mean multiple things, such as personal observation by the team or stories from interviewees. These responses were included under the "Personal experiences/observations" category unless teams specifically stated the type of in-person account.

Many teams responded that they intentionally used surveys, interviews, and personal observation/experience. The prevalence of these responses was not surprising, because as part of the project, students are strongly encouraged to reach out directly to individuals who are affected by the need the team identified. For example, a team who identified a need for more environmentally conscious takeout containers from on-campus fast food restaurants surveyed students who get fast food and interviewed a few employees who work at the fast-food restaurants to gain a more complete understanding of the needs and possible constraints.

The category "other/current methods used" refers to responses that mentioned looking up current solutions related to the need the team identified. For example, a team focused on campus parking issues, described looking into the current approaches that the university uses to manage parking.

Some sources of information that were noted as being intentionally used were also listed as information that was being unintentionally used in Module 1 Question 2. These sources of information include personal experiences/observations and other/current methods used. It makes sense that

Table 3. Categories identified from assessment of Module 1 Question 2 responses, focused on the types of information students are unintentionally using for their design project.

Category	Number of teams
Personal experiences/observations	14
News/media	5
Social media	2
Other/current methods used	6
Hearing from others	11
Prior research/knowledge	3
Website advertisements	1
Rules/codes	1
Pre-existing bias on subject	2

teams could be both intentionally and unintentionally influenced by these sources of information; however, more data is needed to fully understand the ways students used this information.

Teams primarily mentioned information sources that they might come into contact with while doing other things, such as “social media”, “news/media”, “hearing from others”, and “website advertisements” (Table 3). The “news/media” category was distinct from “social media” and included information such as government announcements and broadcasts. Teams also mentioned information that they already have, including “prior research/knowledge” and “pre-existing bias on subject”. One team mentioned using “rules/codes”; however, it is not clear if they meant legal restrictions or social codes.

Teams’ responses to the first question of Module 2 (completed by 20 of the 23 teams) often included specific language from the video. These categories include “currency”, “relevance”, “authority/credentials”, “accuracy/reliability”, and “CRAAP test” (Table 4). Given our assessment approach, we are not able to state how much the video influenced teams’ responses; however, given that the exact language showed up in some of the students’ responses, specifically currency, relevance, and CRAAP test, it is fair to assume that the video had some effect on student responses. Other categories of responses that were present included “impact on stakeholder”, “cost”, “environmental/geographical impact”, “feasibility/practicality”, and “cross referencing”. All of these categories, except “cross referencing” are common considerations within engineering design.

The “Types of Information” listed by the 14 teams who recorded partial responses to Module 2 Question 2 were also responses to Module 1 Question 1. Researched information (online resources or journal articles, for example) was the most common response, followed by surveys. Of the 6 teams

Table 4. Categories identified from assessment of Module 2 Question 1 responses, focused on how students plan to assess the information they collect for their design project.

Category	Number of teams
Currency	3
Relevance	8
Authority/credentials	6
Accuracy/reliability	1
CRAAP test	3
Impact on stakeholder	4
Cost	4
Environmental/geographical impact	2
Feasibility/practicality	4
Cross referencing	3

who were able to partially respond to the CRAAP columns, most of the responses in those columns related to the resource being up to date or recent (5 teams) and university specific (3 teams). Based on the results it seems that this reformatted question will provide students with a structure that supports their reflection on the CRAAP test in relation to their project. For example, one team who aims to improve the roads around their city, mentioned that they will survey people in the area, which aligns with currency, because these individuals have experience driving on the city roads, which aligns with relevance. Another team who was also focused on redesigning roads applied the CRAAP test to a map of traffic flow from the official city website. For currency, they planned to ensure that the map is up to date. For relevance, they planned to use this information to ensure that traffic would be impacted as little as possible by their design. For authority and accuracy, they planned to make sure the website is official and that it is up to date.

DISCUSSION

One goal we had was to develop a module to help students understand the importance and influence of information in making design decisions. After engaging with the module video, we found that students were able to identify a diverse range of types of information as well as a diverse range of information sources. While many of the sources of information did relate to internet resources, similar to the findings of Wertz et al. (2013), there was evidence that students used resources outside of internet resources, including surveys, interviews, personal experiences, and information related to the project task itself. These additional resources could be attributed to the structure of the project assignment, leading us to believe that the way in which projects or problems are structured for student interaction may impact the types of information they engage with during the learning process. Students also identified that similar sources of information could be used both intentionally and unintentionally. Unintentional sources of information seemed more difficult for students to identify. This could be due to the fact that many students may be unaware of the impact that information may have on their decision making if it is not intentionally sought out (Vlassova, Donkin, and Pearson 2014). Though many teams provided responses similar to those in the module video, some teams showed evidence of deep reflection of the impact of unintentional information sources by providing responses such as previous bias and other students' designs and comments as impacting their own decisions.

Our second goal was to help students develop their abilities in assessing the quality of information used in design decisions. Similar to Wertz et al. (2013), we found that, even with explicit instruction, students have difficulty in assessing the quality of information. In fact, in round 1, we found that students had difficulty delineating between the tasks of assessing information quality and assessing design idea quality. We believe that, apart from English courses, students may have never been asked to assess the quality of the information that they use in making decisions (Wilkes, Godwin, and Gurney 2015). Prior literature suggests that knowledge transfer between courses, especially courses separated by disciplines, can be difficult for students (Bransford and Schwartz 1999; De Rosa 2020). Challenges in knowledge transfer between disciplines highlights the need to engage in these types of activities more frequently throughout an undergraduate engineering curriculum. We believe that using a structured method for teaching quality assessment, like the CRAAP test, can be helpful in teaching students how to think logically about the quality of information they use when making engineering decisions. We saw evidence of students' ability to assess the quality of information using the CRAAP test as well as other engineering design related parameters.

Reflection on Implementation

Thinking back on our two implementations of the modules, we identified three key takeaways that will be important for other instructors to consider when incorporating information literacy into their courses. First, it is a challenge to make the space in a course to include instruction on information literacy. Adding additional concepts can be challenging to achieve in first-year engineering programs, which are typically challenged with covering a large number of fundamental and professional concepts in order to prepare students to transition to disciplinary majors in their second year (Brannan and Wankat 2005). At the beginning of each semester of implementation, we had specific intentions to integrate the modules into the design projects within our two first-year engineering courses. Even with these intentions, we found it challenging to identify class time for the modules and had to make decisions about what material to remove from the course to make the space to cover information literacy.

Our second key takeaway is the importance of integrating information literacy instruction into class time and assignments, which has been widely noted by other researchers (Williamson et al. 2019; Leckie and Fullerton 1999; Zhang, Goodman, and Xie 2015). It would have been possible to have students watch the videos for Module 1 and 2 and complete the reflection questions with their team outside of class time; however, using in-class time emphasized the importance of the topic and helped to ensure that students took the conversation seriously. In addition, it provided an opportunity for students to ask questions and seek feedback. The team reflection questions that students completed after watching the videos provided students with the space to consider the instruction on information literacy with their course assignment (Turns et al. 2017). This direct connection between information literacy instruction and the students' design project provided context to the material students learned and an opportunity to practice information literacy skills. While we did dedicate 75-minutes of our class to information literacy, to support students' mastery of this professional skill, further incorporation is likely needed. For example, students could be required to support the table from the Module 2 Question 2 reflection for each of the types of information that informed their design as one of their project deliverables.

Building on the importance of using in-class time for information literacy instruction, our third takeaway is the importance of the whole class discussion. In our assessment of students' responses, we saw that some teams' responses went beyond the examples provided in the videos and provided responses that suggested a deeper level of reflection and understanding. By incorporating a whole class discussion, these deeper responses can be shared, encouraging other teams to think about how these responses relate or do not relate to their own experiences (Bereiter and Scardamalia 2014). In addition, the whole class discussion provided the opportunity for the instructor to provide real-time feedback to students. Since thinking about information literacy might be new to many first-year engineering students, this type of formative feedback may motivate students to move beyond their initial responses and think more deeply about the topic (Clark 2012). Along with the importance of the whole class discussion, we would also recommend encouraging students to update and modify their responses as other teams share and/or providing additional time after the class discussion for teams to expand their initial answers. This approach would increase the opportunity for students to learn from one another. We also suggest that instructors allow students and teams the opportunity to brainstorm potential biases that may impact design choices for their problem and customer. Once this brainstorming list is complete, students can then reflect on if intentional or unintentional information sources led to biased design decisions for their project.

CONCLUSION

This work describes the development of a series of modules intended to help first-year engineering students develop information literacy skills in the context of engineering design projects. Informed by previous literature and work from a portion of a larger study, we developed two modules to help students identify sources of information useful for their design project and to help students assess the quality of information they use. Assessment data from two iterations of implementations shows that students were able to identify a range of resources mostly associated with internet sources. Data also showed that while some students were able to assess quality of information using a structured process, many students' assessments were superficial and needed more time and instruction to improve assessment quality. Our personal experience, along with previous literature, suggests that integration of instruction on information literacy is important but will require intentional effort and focus in order to integrate into a full first-year engineering curriculum. These modules are available for use and testing in other first-year engineering contexts.

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AUTHORS

Courtney Faber (she/her) is a Research Assistant Professor and Lecturer in the Cook Grand Challenge Honors Program in the Tickle College of Engineering. She is also the Director of the Graduate Engineering Education Certificate Program. She teaches a variety of courses including, two first-year engineering courses that focus on physics for engineers and the engineering design process. Her research focuses on developing formal and informal education practices to support complex problems solving and identity development within engineering.

Rachel Ellestad (she/her) is the Interim Director, Senior Lecturer, and Research Assistant Professor in the Jerry E. Stoneking Engineering Fundamentals Program in the Tickle College of Engineering. She teaches courses in the first-year program, including courses that focus on introducing engineering physics topics, professional skills, and student success topics. Rachel also serves as an instructor in the Graduate Engineering Education Certificate Program at UTK. Her research focuses on investigating ways to support metacognitive development among undergraduate engineering students as well as faculty development for teaching metacognition.

Alexis Walsh (she/her) is an Undergraduate Research Assistant from the Industrial & Systems Engineering Department in the Tickle College of Engineering. She has conducted research in engineering education for two and a half years at the University of Tennessee and will be graduating in May 2021 with a degree in Industrial Engineering and a minor in Reliability & Maintainability.

APPENDIX 1

Handouts for class discussion of Module 1 and 2 from first implementation

Module 1: What is Information?

1. What types of information are you intentionally using to help with your current design project?

2. What types of information are you being exposed to (or have been exposed to) unintentionally that may be impacting your design decisions?

Module 2: Assessing Information

1. Of the types of information you defined yesterday, how did you determine what information to use for your design vs. what information to discard or ignore?

2. How could you use the C.R.A.A.P. test to help you think about information for your design project moving forward?

Currency	
Relevance	
Authority	
Accuracy	
Purpose	

APPENDIX 2

Handouts for class discussion of Module 1 and 2 from second implementation

Video 1: What is Information?

1. What types of information is your team *intentionally* using to identify a solution to your problem statement?

2. What types of information are you being exposed to (or have been exposed to) *unintentionally* that may impact the solution you identify?

Video 2: Assessing Information

1. Of the types of information, you defined, how do you plan to determine what information to use as you identify a solution in Project 2 vs. what information to discard or ignore?

2. List 3 types of information your team plans to collect to identify a solution. Describe how you will use each element of the CRAAP test to assess each type of information. *You can use the example provided as a guide; however, you need to add specifics that are relevant to your information.*

Type of Information	Source of Information	C Currency	R Relevance	A Authority	A Accuracy	P Purpose
Personal experience from person's perspective who has dealt with the problem we are working on	*Personal interview with a person who has experience with problem*	*Ensure that we are interviewing people who have recent experiences with the problem*	*Information needs to be relevant to the context of our problem*	*Ensure that the people we interview have actually had that experience*	*Ensure that the information we present accurately represents the person's experience*	*Use open-ended questions so that we don't guide the person's responses to what we want*