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# Educating for Evidence Based Decisions in Engineering: The View as Librarian and Instructor

Amy S. Van Epps
*Purdue University*, vanepa@purdue.edu

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# Educating for Evidence Based Decisions in Engineering: The view as Librarian and Instructor

**Prof. Amy S. Van Epps, Purdue University, West Lafayette**

Amy S. Van Epps is an associate professor of Library Science and Engineering Librarian at Purdue University. She has extensive experience providing instruction for engineering and technology students, including Purdue's first-year engineering program. Her research interests include finding effective methods for integrating information literacy knowledge into the undergraduate engineering curriculum.

# Educating for Evidence Based Decisions in Engineering: The view as Librarian and Instructor


## Abstract

The First Year Engineering program at Purdue University is regularly reviewed and revised to adapt to the needs of the students, feedback from teaching faculty, and the changing needs of the university curriculum. In the last year, a unifying theme was added to the class to help tie all the different activities together. That theme was “evidence based decision making in engineering”, a perfect fit for introducing and discussing information literacy many times throughout the semester, rather than in a single, isolated session.

As instructor for one section of the class, the author identifies benefits to including this message throughout the semester, evidenced by the resources students used as seen during spot reviews of homework assignments and when listening to group work during class. Post-class reflections recorded by the instructor on how class went and what students struggled with, particularly related to identifying information needs and appropriately supporting those needs with evidence, form part of the data for analysis.

A content analysis of the common PowerPoint slides provided for all sections of the class identifies when in the semester the information content is included and in what context. This analysis will produce an outline of mechanisms that could be used in other settings to introduce information literacy content and reinforce the need for quality evidence in making decisions.


## Introduction

Embedding information literacy content into the curriculum has been presented as an ideal way to teach the information in a meaningful way for the students [1–3]. At Purdue University there is not a single course all new students must take, so it is important for the librarians to work with the first year engineering program to ensure the engineering students get an early introduction to the use of published resources in engineering design.

The first year engineering course at Purdue University is taken by all incoming and transfer students who intend to major in engineering. Course enrollment is around 1,600 students divided between 14 sections of the class. Each section of the course has 120 students as the maximum enrollment, and most sections begin the semester at class capacity.

The course has a faculty coordinator and a team of instructional support staff to help keep the sections aligned, coordinate common exams, and maintain the course blackboard site. There are two classrooms used to teach, a studio classroom, where there are laptop computers available for every other student (60 computers supplied), and a laboratory setting where there are 120 laptops available. Students may also bring their own laptops, which enable the class to be taught in the studio classroom with a reasonable expectation that each student has access to a computer.

Instructors have some flexibility in how information is presented during a class or shuffled between class sessions, provided the content is covered in a timely fashion to meet preparation expectations for in class activities, homework, and exams that are common to all sections of the course.

Quizzes are given at the discretion of the section instructor and are used in a couple of ways, to ensure the online modules have been viewed prior to class, and to gather summative information about how well students have learned the content covered in class.

In the fall semester 2012, for one section of the course, a librarian had the opportunity to be the instructor of record, not a secondary instructor or limited to participating in teaching just the information literacy part of the content and the grading. This option was available since the librarian-author has multiple engineering degrees as well as a MLS degree.

## Purpose

This paper reviews the student work from one section of the first year engineering course related to information literacy. The analysis provides an empirical measure of how well students are able to complete various information literacy tasks required of them throughout the semester.

## Curriculum

*Course structure*

The course learning objectives presented in the syllabus are:

Successful completion of this course will enable you to:

- Examine and analyze career information from various resources to make informed decisions about which engineering discipline to pursue.
- Explain the critical role of cross-cultural and multidisciplinary teamwork in nurturing diverse perspectives and the creation of innovative engineering solutions that meets the needs of diverse users.
- Reflect on your teamwork and leadership abilities, recognizing how your behavior impacts the whole team, and making team process adjustments whenever necessary.
- Explain critical and diverse uses of modeling in engineering to understand problems, represent solutions, compare alternatives, make predications, etc.
- Use multiple models, estimation, and logic to triangulate and evaluate information coming from various data sources.
- Collect, analyze, and represent data to make informative explanations and persuasive arguments. *
- Implement iterative processes, rich information gathering, and multiple modes of modeling when solving complex design problems. *
- Use systematic methods to develop design solutions and compare design alternatives.
- Consider the interconnectedness among social, economic, and environmental factors (in the context of sustainability or systems) when solving engineering problems.

Two of the course goals, marked with an asterisk, can easily be seen by most librarians to relate directly to information literacy skills the students should possess by the completion of this course.

Each class session has more specific learning objectives presented at the start of each class and compiled into a larger exam study guide.

The learning objectives for the information literacy content, which are a combination of the objectives for two class sessions, include:

Doing Research – Information Literacy

- Explain why information gathering is an important part of an engineering design process
- List and apply three criteria for evaluating the trustworthiness of information resources
- Identify and gather necessary elements of a citation
- Include complete and correct in-text citations in written documents (including citations for image sources)
- Include a complete reference list in written documents
- Explain how research and information sources are related to making evidence-based engineering decisions

Portions of this content are taught at two different times during the semester. Initial conversations about high quality resources occur early in the semester, during the second week, when the students are being introduced to Model Eliciting Activities (MEA). MEAs are open ended design projects in real-world, client driven scenarios [4]. As an early step in completing and MEA, students need to find information to help define the context of the situation for which they are designing a solution.

Week 2 focuses on a discussion of trustworthy sources and data literacy through fact checking and logically thinking about the numbers discovered in a resource and if that information makes sense. The discussion is held as part of a think, pair, share process where students are asked to think about 3 questions individually -- What does it mean to **find** good information sources?, **Use** information appropriately?, and **Cite** the information sources appropriately? -- then share those ideas within their teams, and finally with the whole class during a discussion.

During the class sharing portion, one member of each team was asked to write the criteria they developed on the white board walls around the laboratory classroom. Then the instructor lead a conversation about what was meant by “credible” which appeared in many of the responses to the questions. The outcome was a feeling by the instructor that the students understand the process of information discovery, what it means to evaluate that information and what makes a source ‘good’, and that appropriate use of that information includes citing the sources of information in a report.

Information literacy content returns explicitly during the ninth week, when the student teams are in the early stages of the course design project. Week 9 includes an in class activity (ICA) where students are asked to complete different tasks that exhibit pieces of information literacy skills, in particular critical evaluation of information on a webpage and appropriate attribution of sources.

The content presented during this class was originally created four years ago as part of the libraries work with the redesign of the first year engineering course. Much of the course content had matured around this module and it is time for this content to be reviewed and redesigned. Additionally, during the class session this year, the librarian-author was attempting to get additional tasks completed with the student teams, and reworked the lecture and activity time to provide an opening for team feedback. As a result, the information literacy content was not well presented.

**Student tasks**

The student output from the activities described above lends itself to analysis for a look at student understanding and ability to execute information literacy knowledge. More detail on each task and the student work available for analysis is presented below.

The first task students were asked to complete was a problem on the homework assignment following the lecture during week 2. The ability to apply the information literacy skills is assessed as an individual skill in the model eliciting activity (MEA) context setting activity, which occurs in the third week of the semester and builds on the class discussion in week 2. For context setting, students are asked to find resources to inform their thinking and decision making around the topic of the MEA. The task is presented below.

> *Instructions to students- MEA Context Setting*
>
> Design competitions that focus on the performance of designed objects abound. Use and document (with proper citations) at least ***two high quality*** external resources to learn ***three*** things about judging design competitions in general (not just for paper airplanes) that are relevant to this problem context.
>
> In the Context Setting box on the MEA 1 interface, list, ***in your own words***, the ***three*** things you learned and ***explain how each is relevant to this problem context***. In the same box, below the three things learned, list your citations using APA format. (For help with APA reference formats, see http://owl.english.purdue.edu/owl/resource/560/01/)

During week 9, there was an in class activity that is paired with the lecture content for the day.

The activities ask the students to go to a specific site and evaluate if the information is logical and provide a reason why the site should or should not be trusted. Next they are to evaluate two different sites related to the Engineering Grand Challenges (URLs provided) and evaluate the credibility of each and compare them. Finally students need to identify what information is

required when providing a complete citation of a website. Responses to the ICA questions were gathered on a worksheet that was to be submitted by each student at the end of the class session.

As noted above in the lecture section, this material was not treated well due to a need to provide feedback on the semester project, so the students were given minimal guidance on completing this assignment. Previous class discussions related to this material were conducted in the second week and helped offset the lack of attention during the lecture in week 9.

A quiz was given the week after the in class activities described above. The actual questions the students were asked to respond to and what sorts of responses were anticipated are presented below (both questions were manually graded by the instructor):

*Quiz Questions and Response Guidelines*

1. Based on the following citation, what type of information would expect to find from this resource?

SDS Skateboards. (2012). *Stella Longboards: New longboard shapes, colorways and sizes.* Retrieved from http://www.sdsskateboards.com/stella.htm (1 pt)

Any information that identified this site was most likely selling longboards and thus would have information on sizes and shapes, along with cost information.

2. For the citation given in the last question, state if you would use the resource in a research and design project, and explain why you would or would not use the information. (1 pt)

Either yes or no was an acceptable answer, as long as the student could provide an acceptable justification. See a couple of examples below:

No – the site is likely biased due to the .com address, and is trying to sell something so might not be the best source for documentation on longboards.

Yes – as a retailer of longboards, they will know the specifications of current boards, which would help design a system for holding boards with new dimensions and knowing those dimensions is important.

The second exam of the semester was scheduled for a couple of weeks after the week 9 lecture, the in class activity and the quiz questions, and included the question presented below.

This exact resource was used in many of the sections during one of the week 9 lectures, so the question should have been very familiar to a large portion of the students in the course. In my section, due to the reworking of the activity time and this example was removed. Therefore, the results of the exam question are more reflective of students' knowledge of APA format, rather than recall of material presented during class.

*Exam question*

**Problem 9 (4 points)**

The table below provides information about a web page.

| | |
|---|---|
| Article title | Indiana's Diploma Requirements |
| Author | Indiana Department of Education |
| Year updated | 2012 |
| Website | http://www.doe.in.gov/diploma-requirements |
| Department location | Jolly, Indiana |
| Webmaster | Steve Jones |

Select the reference list citation for this web page in APA format. [Circle **one** answer.]

A. Indiana Department of Education. (2012). *Indiana's diploma requirements*. Retrieved from http://www.doe.in.gov/diploma-requirements
B. Jones, Steve. (2012). *Indiana's diploma requirements*. Retrieved from http://www.doe.in.gov/diploma-requirements
C. Bean, S., & Jones, S. Indiana's Diploma Requirements. Indiana Department of Education, 2012.
D. Indiana Department of Education (Jolly, Indiana; 2012). *Indiana's diploma requirements*. Retrieved from http://www.doe.in.gov/diploma-requirements

**Population**

The section taught by the librarian-author had a distribution of students that is typical of the first year engineering program at Purdue University. The data were gathered from the 119 students present during the first day of class and a quick analysis shows that 39.5% of the class was from within the state of Indiana, and another 15.1% of the class calls Illinois home. The remaining domestic students constituted another 26.1% of the class and represented 16 other states. The final 19.3% of the class were international students, with the majority (56.5%) of those students coming from China.

**Data**

The data will be reviewed in the order the material was presented and student output created during the class.

For the first assignment that included information skills, the MEA context setting work, 97 of 119 students completed the task. In 96 of the 97 responses, students included some form of document references. Of those 96, only about 23% of the students got most of the elements included in the citations, even if most of them did not get the APA format completely correct. Another approximately 63% of the students got at least one of the references mostly complete.

The remaining approximately 14% typically misidentified the type of resource found, and wrote an incorrect reference as a result. For this study, mostly correct meant the student used the proper type of citation, i.e. website for a website, not a journal article, for a particular type of resource, at least 75% of the required elements for that reference type are present, and that the elements were in basically the correct order. The analysis of relevance of the resources shows that ~21% of the students provided 2 resources that were logical for the information needed to complete the task. Another 55% presented at least one logical reference, while the remaining 24% included references, but it was not clear how they were related to the assignment. Depending on how the students read the task requirements, they may have been reviewing information on judging design competitions, which is related, although not directly to the performance of the designed objects. As long as students were able to present a clear case for the information they learned from a resource, and how it related to their design problem, it was regarded as logical. Resources were considered to be quality if the source was scholarly (e.g. journal article) or an unbiased and informative website based on the page details in the reference and a quick review of the site. Only 9% of the students identified 2 quality resources. The majority of the students (61%) included at least one quality source.

Of those 96 students who included the required references, only 20 students (~20%) included in-text citations to support the information used to state what they learned about judging competitions.

While this analysis is rather basic, it does show that the students can and will find resources and include citations when the instructions to do so are clear and there are points attached to the task. What also becomes clear is that students do not exhibit an awareness of what it means to actually use that information in support of their learning and in presenting written arguments for a decision.

The student work from the week 9 in class activity shows an ability to reproduce what was discussed in the lecture portion regarding the quality of the data presented (question 1, 98% correct), clarity on how to evaluate websites (questions 2, 97% correct and 3, 90% correct), and an ability to articulate what pieces of information are required in a citation to locate a website again in the future (question 4, 61% correct). Question 4 asked the students to “List the information you would need to give to someone else so that they can find the article you were assigned in class”, and many of the students provided the article title and instructions to use Google or gave just the URL. While these options would accomplish the intent of the question, neither provides an accurate list of the reference elements, which was the intent. The low percentage of correct answers to Question 4 is likely an artifact of the poorly phrased question, rather than student ability.

The high percentage of correct responses to these questions demonstrates that the students have this basic knowledge, particularly when it is asked in a fashion very similar to how it was taught, also known as inert knowledge.

The quiz, taken during class the week after the in class activity, was completed by 113 students. Of those 113, 102 (90%) students were able to make reasonable assumptions about the type of information that would be found at the site with the provided reference. Even if the students could not determine what information they would expect to find on the page, 106 of the 113 (94%) provided good reasons why they would or would not use the source for a project.

In most cases the students who did not make an accurate assessment of the type of information to be found on the page were unable to give a coherent response on why they would or would not use the site. In a couple of cases, students who inaccurately indicated what could be found on the site were able to clearly articulate why they would not use such a site for a project, similar to my anticipated response of the site being commercial and trying to sell materials and therefore being biased.

Out of 112 student responses on the exam question, 83% got the correct answer (A). 5.4% selected option B, and 11.6% selected option D. The students were able to tell that option C did not conform to APA format as none selected that choice.

**Discussion**

The analysis of the questions and activities students were asked to complete individually all show similar results; an ability to construct references for websites, identify complete references, and an ability to construct logical explanations of what a resource could be used for and why it should or should not be considered a trusted source for that information.

While the analysis was not looking specifically for gaps in student knowledge, it could be seen that students are missing some skills, including an ability to determine if what they are looking at is content other than a webpage, like a journal article, and then write a correct reference. In addition, the written documents show the students lack of understanding about when they have stated a claim and need to support that statement with evidence (an in-text citation).

**Future considerations**

Too often librarians are relying on anecdotal information or the requests of the course instructor rather than conducting a thorough analysis of the learner before creating instruction for a class. This experience allowed the librarian-author an opportunity to conduct a more complete learner analysis that will lead to new instruction interventions.

Additional analysis of the data from this class can be used for a discussion of cultural stereotypes about information use and ethical writing practices for domestic and international students. Since 20% of this class was students from non-US cultures, it can be seen that the lack of ethical writing practices is much broader than the often assumed cultural misunderstanding and different early educational experiences.

This paper is limited to the individual work the students completed during the semester. Analysis of the team products would provide a look at how working in groups may enhance the information literacy components of a design product.

## Conclusions

The opportunity to teach a class of first year engineering students gave the author a new look at the information taught to fulfill information literacy skills and has generated new ideas on what content would be better taught to advance the students' ability to think critically about information and use it ethically to support the design decisions they are making.

The analysis shows many students have inert knowledge of the information literacy skills frequently taught. This reinforces the need to move our instruction opportunities into areas that help students activate this knowledge and make it part of their regular research process.

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