

# **AC 2007-2058: EFFECT OF LIBRARY INSTRUCTION ON UNDERGRADUATE ELECTRICAL ENGINEERING DESIGN PROJECTS**

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# Effect of library instruction on undergraduate electrical engineering design projects

## Abstract

This study examines the effect of library instruction on two sections of the same senior-level electrical engineering course in analog integrated circuit design. One section received a one-hour library instruction session while the other section did not. The premise of the study is that inclusion of library instruction will result in higher utilization of scholarly resources in the students' final projects for which they were required to design, analyze, and simulate a circuit that meets a given set of specifications.

The results confirm that the section that received library instruction consulted and cited more scholarly resources than the section that received no training in use of library resources. We also found a positive correlation between the students' use of scholarly materials and their final project grade.

## Introduction

Engineering students, like the professional engineers documented in the literature<sup>1,2</sup>, tend to “minimize loss rather than maximize gain” when searching for information for their engineering projects. That is, they gravitate toward sources with which they are familiar—e.g. colleagues or peers, personal files, textbooks, lecture notes, and the internet, rather than spend the time to search for more authoritative sources of information. Engineering students are often unaware of the scholarly resources contained in research databases provided by their college or university library.

This work studies the effectiveness of collaborative teaching between engineering and library faculty. Fundamentally, we wish to investigate whether devoting valuable class time to library instruction is a worthwhile investment. Through a detailed literature review and experimental study, we will explore the impact of focused library instruction on the quality and quantity of cited scholarly references in students' final project reports. Two subsequent offerings of the same course are compared: one with intensive library instruction and one without. A bibliographic figure-of-merit (FOM) is defined and used as a tool to study the effect of the library instruction. We then explore the correlation between the bibliographic FOM and the final project grade.

## Literature Review

As a group, engineers and their information-seeking behavior have long been of interest to librarians and other information professionals. Extensive research has been done on how engineers go about finding the information they need in their work. Several studies have found that engineers tend to rely heavily on personal stores of information and their colleagues, and

only when those sources fail to provide the information they need, will they turn to the engineering research literature, libraries, and librarians.<sup>2-6</sup>

But what about engineering students? Does their information-seeking behavior mirror that of professional engineers? Kerins, et al, have studied engineering students in Ireland and found that, like professional engineers, they “seem to have a preference for channels that require the least effort... such as the Internet.” They also found that libraries were low on the list of sources consulted when searching for information for an engineering class.<sup>7</sup> In 1994, Ackerson and Young found that engineering students were “among the least likely of students enrolled in the science and technical disciplines to know about and use the literature in their field,” relying instead on informal channels of communication.<sup>8</sup> With the proliferation of easily accessible, unreviewed, non-authoritative information on the Internet, we have cause to worry for our future engineers’ abilities to find and use reliable, authoritative information in their decision making and engineering designs.

One of the major factors influencing an engineer’s choice of information source is its accessibility, or perceived accessibility.<sup>1-2</sup> Since “the more experience engineers have with an information channel or source, the more accessible they perceive it to be,”<sup>1</sup> it makes sense to introduce engineering students to a variety of reliable information sources while they are in school so that when they are working in industry or academia, they will have familiarity with them and be more likely to consult them. Rodrigues states that “the ideal time for the engineer to develop his or her information gathering and management skills is not when entering the corporate world, rather, it is during the engineering education,”<sup>9</sup> when they have access to more information resources than most corporate libraries have as well as trained information professionals (i.e. librarians) to guide them in the selection and use of these resources.

Weiner, in her 1996 article describing librarians’ involvement in a mechanical engineering design class at MIT, states that “design courses offer the students a different experience than that which is supplied in their more analytical courses and it is here that exposure to the concept of library research may be the most beneficial and valued.”<sup>10</sup> Christine Bruce, an internationally recognized expert on information literacy issues in higher education, states that if library instruction is to be effective, it must be embedded in an existing course, have a direct link to a class assignment, and be delivered when needed.<sup>11</sup>

Ackerson and Young, in a study comparing different library instruction methods in a technical writing course for engineering majors, found that students who received extra instruction in the use of periodical indexes during the course showed significantly greater use of periodical articles in their term paper bibliographies and, when rated for quality, their bibliographies were of significantly higher quality than those of the control group, which did not receive extra instruction.<sup>8</sup>

Holland and Powell also found that exposure to library resources as an undergraduate had long-term benefits for engineers. They surveyed professional engineers 8-12 years after graduation about their information use in their jobs. The engineers who received instruction in information access and use as undergraduates were able to identify more information resources available to them and had a higher opinion of formal sources of information, such as libraries, than did respondents who did not receive library instruction as an undergraduate.<sup>12</sup> More recently,

Okudan and Osif studied the effect of including library instruction in the curriculum of an engineering design course at Penn State University and found that the “[a]ddition of a guided research intervention to the engineering design teaching improves the design performance in engineering teams.”<sup>13</sup>

In this study, we propose to give engineering students an introduction to some of the most important sources of reliable, peer-reviewed electrical engineering information available (i.e. IEEE Xplore, a full-text database of peer-reviewed journal and conference literature focusing on electrical engineering research, and Inspec, a bibliographic database covering electrical engineering research literature from 1896-present) as part of an undergraduate electrical engineering design course. We study the impact of library instruction on the students’ use of scholarly resources and their performance in electrical engineering class design projects.

## **Experimental Procedure and Design**

Our hypothesis is that the inclusion of rigorous library instruction will result in an increase in the quality and quantity of the scholarly resources (i.e. journals and professional conferences) cited in undergraduate design projects. The study also seeks evidence that the scope, creativity, and performance of the students’ designs increase as a result of their newfound research abilities.

Two groups of students from consecutive offerings of a four-credit senior-level electrical engineering course, Analog Integrated Circuit Design, were studied in this work. Both groups were taught by the same professor and were assigned the same final design project. The first offering of the course (33 students) included no explicit library instruction. The second offering (45 students) included one hour of class time dedicated to understanding the importance of and procedures for acquiring published resources. Additionally, the Engineering Librarian was made available for student questions and research help outside of class.

A librarian from the University of Washington’s Engineering Library prepared a one-hour lecture focusing on finding scholarly resources. As shown in Okudan and Osif,<sup>13</sup> close collaboration between the librarian and course professor is crucial. For this study, the librarian was given a detailed overview of the class content, syllabus, and project assignment. The librarian was familiar with the relevant search terms and was aware of representative publications that were relevant to the project. The Engineering Librarian presented a one-hour instruction session covering the process of doing a literature search using the IEEE Xplore and Inspec databases, the peer review process, the differences between journal articles and conference papers, and proper citation of references. The importance of knowing how to access published, peer-reviewed resources was stressed because once the students graduate, they will no longer be able to rely on a professor or a textbook to fill their information needs.

Both offerings of the course were assigned the same design project. The students were tasked with the analysis, design, and simulation of an integrated MOSFET operational transconductance amplifier (OTA) that met pre-defined specifications. In addition to these specifications, the students were allowed to choose one of four performance variables to optimize (amplifier gain, output voltage swing, amplifier bandwidth, amplifier power dissipation). It was expected that all

students would meet the basic specifications and their grades were partially based on the optimization of their chosen variable relative to their colleagues. Thus, there existed friendly competition between the project groups and students were incentivized to think creatively to design circuits that outperform circuit topologies presented in the lecture notes and textbook. Most students worked in pairs. The project deliverables included an extensive report and an in-class presentation where the methodologies and results were shared with the students' colleagues.

To test our hypothesis, the bibliographic references cited were examined for quality and quantity of references used. A bibliographic figure-of-merit (FOM) is defined and used to test the hypothesis. Our figure-of-merit is a weighted sum of the scholarly resources cited, where the weighting is determined by the relative ability of the publication to provide the student with viewpoints and insight beyond that directly learned in class. The weightings used in this study are provided in Table I.

*Table I. Weighting for Bibliographic Figure-of-Merit (FOM)*

Scholarly journal article	2
Professional conference paper	1
Class Textbooks and Lecture Notes	0.5

Because articles appearing in scholarly journals are much more rigorously reviewed before publication than conference papers, we assigned a higher relative weight for journal articles. Reduced weighting is given to the assigned class textbooks and lecture notes since these resources were readily available to all students. Note that world-wide web references have not been considered in the bibliographic figure-of-merit. It has been well-documented in Kerins, et al. that engineering students are extremely internet-literate, but can become overly reliant upon internet search results of dubious accuracy.<sup>7</sup> For this reason, we limit this study to peer-reviewed scholarly resources, class textbooks, and lecture notes.

Students were not provided any additional credit for using/citing bibliographic references, nor were they informed about the experiment before the project was completed. The duration of the final project was approximately three weeks, which provided the students ample opportunity to acquire reference materials as desired.

Additionally, we investigated the correlation between the bibliographic figure-of-merit and the final project grade. Grades were assigned based on the following criteria: meeting the basic project specifications, completeness and clarity of the project report, quality and technical accuracy of final presentation, and the optimization of the chosen design variable. Grading was blind, and the references cited were not considered in the determination of grades.

## **Results and Discussion**

We analyzed the bibliographies of the final projects from both sections of the class. Class A (n=15) received no library instruction, while Class B (n=20) received one hour of focused library instruction. We then calculated the bibliographic figure-of-merit for each group's project by

assigning the values as shown in Table I. After discarding the highest and lowest values from each sample, the average figure of merit for Class A was 0.866. In Class B, the average figure of merit is 3.125, indicating greater use of scholarly resources in preparing their final projects ( $P < .05$ ).

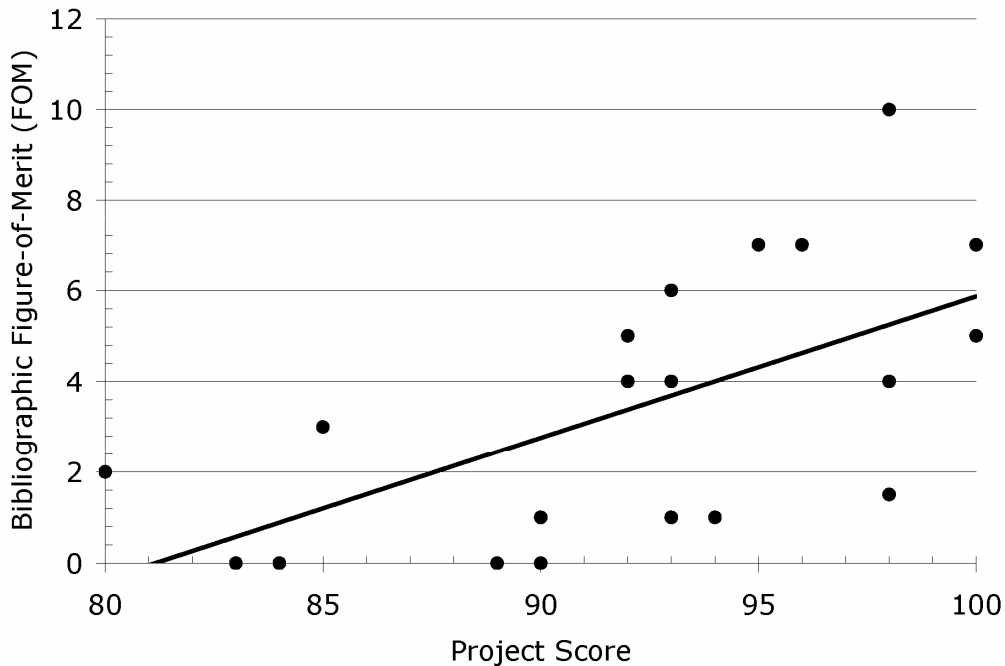
We also analyzed each type of resource (journal articles, conference papers, class textbooks and lecture notes) to see if there was an increase in use and if that increase was statistically significant. Using the Student's *t*-test, where each "case" was a final project bibliography, there was a significant increase in the use of journal articles by Class B, from .27 to 1.05 journals cited per bibliography ( $P < .05$ ). For conference papers, there was also a significant increase in use, from an average of 0 in Class A to an average of .45 in Class B ( $P < .05$ ). Citations to class textbooks and lecture notes remained essentially unchanged, with a mean of .53 for Class A and .50 for Class B ( $P > .05$ ). These results are to be expected, since textbooks and lecture notes were not covered as part of the library instruction session. These results are summarized in Table II.

*Table II. Descriptive statistics by type of resource*

	<b>Total Citations</b>	<b>Journal Articles</b>	<b>Conference Papers</b>	<b>Textbooks &amp; Lecture Notes</b>
<b>Class A (n=15)</b>				
Mean	0.8	0.27	0.00	0.53
SD	0.77	0.59	0	0.52
Min	0	0	0	0
Max	2	2	0	1
Sum	12	4	0	8
%	100	33.33	0	66.67
<b>Class B (n=20)</b>				
Mean	2	1.05	0.45	0.5
SD	1.87	1.32	0.89	0.61
Min	0	0	0	0
Max	6	4	3	2
Sum	40	21	9	10
%	100	52.5	22.5	25

This study suggests that the incorporation of brief but focused library instruction can have a significant impact on the number and quality of references cited in the students' final projects. Although this result is intuitively obvious, we feel it is significant since one of the goals of this senior-level design class is to teach the students the tools needed for advanced research in their future academic or industrial careers.

We have already shown a significant correlation between library instruction and references cited. But what is the value of a cited reference? To answer this, we studied the correlation between bibliographic FOM and project performance. Figure 1 shows the project grade vs. bibliographic FOM for Class B (Class A was not considered due to extremely low citation level).



*Figure 1. Final project score vs. Bibliographic FOM*

Figure 1 shows a positive correlation ( $c > 0.5$ ) between grade and references cited. Although this could be explained by the generally high performance of detail-oriented students, the results are encouraging and could indicate a higher level of research ability resulting from finding, digesting, and citing scholarly references.

## Conclusion

This paper reports on the effects of focused library instruction on electrical engineering design projects. Two classes in consecutive offerings of the same course were assigned the same final project. One of the classes had a dedicated hour of class time devoted to library and scholarly resource instruction. Our study found that a brief, intense library instruction period had a significant impact on the number of scholarly resources referenced in the final design project. Additionally, we found a positive correlation between the number of references cited and the final grade of the design projects. This study demonstrates that a substantive instructional collaboration between engineering and library faculty can yield significant benefits in the undergraduate curriculum.

Although this comparative study of two undergraduate classes cannot be considered representative of engineering students in general, we believe the results show that the inclusion of even one session on finding and accessing scholarly resources can have a significant effect on students' use of these valuable resources. Since research shows that engineers in the workplace tend to use sources with which they are familiar, it is important to allow students to gain a familiarity with scholarly engineering resources while they are in school, so that they will be more likely to turn to them in the future.

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