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## **AC 2012-3736: ENGINEERING AN INFORMATION LITERACY PROGRAM FOR FIRST-YEAR ENGINEERING STUDENTS**

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Mary Strife has been at West Virginia University since 1995, serving as the Director of the Evansdale Library and an Engineering Librarian since 2001. She has almost 30 years experience in the library and information profession in science/engineering and public/access services positions at Cornell, University of Rochester, and SUNY, Utica/Rome. She has been in ALA/ACRL for 30 years, SLA for 25 years, and ASEE/ELD for almost seven years.

# Engineering an Information Literacy Program for First Year Engineering Students

## 1.0 Introduction and Background

Technical writing is an essential skill for all developing and practicing engineers.<sup>1,2</sup> With the onset of the information age there has been an increasing awareness of the importance of information literacy and students' challenges in attaining it.<sup>3-5</sup> The current information driven environment requires engineering students and graduates to be able to find, evaluate and use information effectively.<sup>6-9</sup> This process includes: performing literature reviews to find needed information from appropriate, credible sources<sup>10</sup>, such as electronic databases and libraries; to credit the work properly; and to effectively communicate solutions to problems. In particular, learning to complete a literature search is a significant part of finding journal articles and technical papers which not only inform their research<sup>11,12</sup> but provide high quality examples of various types of technical communication<sup>13</sup>.

The first engineering problem solving course that first-year students take at West Virginia University, a large land-grant university in the mid-Atlantic region, requires students to write at least two technical reports. Students, typically, have difficulty with the following: (1) understanding the parts of a technical report; (2) defining and avoiding plagiarism; (3) evaluating their online sources; and (4) finding appropriate sources from which to perform a literature search for background information on their assigned topic.

To address these issues, engineering faculty collaborated with campus librarians<sup>14,15</sup> to: (1) write new information literacy learning objectives for that course; (2) create specific instructional modules, including in-class activities combined with short lectures, online assessments, and homework/reinforcement activities; and (3) construct a grading rubric for technical reports that include information literacy issues as part of the grading criteria for technical reports. This work was funded by a campus Information Literacy Course Enhancement grant sponsored by the University Libraries and the Office of the Provost.

Three content modules, which used the computer-lab classroom and course support technology, were taught by the Information Literacy experts (the Librarians) to more than 700 students in 18 sections of the course. The nine (9) primary engineering course instructors implemented the grading rubric in all technical reports required.

This paper presents the learning objectives and grading rubrics and describes the content modules developed through this project. The results of the assessment of student learning and of the development process are presented as well. Recommendations are made for additional modifications to more effectively prepare students to search and use information correctly and appropriately, giving them skills needed to succeed as a student and as an engineering professional.

## 2.0 Integrating Information Literacy into the Freshman Engineering Course

The targeted course, Engineering Problem Solving I (ENGR 101), is a required freshman level course that all engineering students take before declaring their engineering-discipline majors. It is a semester long, two credit hour project-based course. It introduces engineering students to and provides opportunities to hone the fundamental skills required to succeed within and beyond the classroom. Students apply mathematics to solve engineering problems, acquire team-building as well as written and oral communication skills, develop and enhance design abilities, and use the computer as a tool for analysis, design and communication. By applying the knowledge to three projects throughout the semester, students demonstrate an understanding and appreciation for the concepts presented. Deliverables on projects include, among other things, technical reports and oral presentations. The focus of this study is the writing of the technical reports.

The ENGR 101 faculty collaborated with the engineering librarians to develop the new information literacy content modules for the course. Three content modules, which used the computer-lab classroom and course support technology, were taught by the Information Literacy experts (the Librarians) to more than 700 students in 18 sections of the course. The new instructional units included information on going beyond Google to using accepted scientific and engineering databases to find sources, citing sources appropriately, and ways to avoid plagiarism. The units were presented in three 50 minutes classes that included in-class activities and incorporated online exercises into the regular assignments associated with the students' projects.

In each section, the engineering faculty taught the general technical report writing content, including parts and content of technical reports.

The timing of the information literacy sessions within the course structure was critical. For instance, the sessions on navigating the internet to find peer reviewed articles, utilizing the STEM databases and other library resources, citing references and avoiding plagiarism were conducted before the first technical report was due. The three information sessions were:

- Week 2: *Introduction to Information*. This session covered how to determine if the information you read is reliable, a Google-like search tool called *Summon*, when to cite the source of information, and how to avoid plagiarism.
- Week 5: *Information Tools*. This session covered the types of information, the parts of a citation, how to cite an article, and how to use library databases to locate sources (books, journal articles, and technical reports) and find a known citation.
- Week 11: *Intellectual Property*. During this session, the concept of Intellectual Property was defined within an engineering context, the four major forms of intellectual property were introduced (Trade Secrets, Copyright, Trademarks, and Patents), and students were taught how to search for patents.

For each session, pre- and post-tests were assigned as well as in-class activities with librarian and faculty present in class to assist as needed. The assignments from the librarians were reinforced in course work assigned by faculty. In this way, the information literacy component was seamlessly integrated into the curriculum.

## 2.1 Modified Learning Objectives

Course learning objectives were modified to reflect the new emphasis on expanded technical writing skills. The learning objectives were framed as expected student outcomes. Existing student outcomes were clarified by specifying activities related to preparing technical reports that students will be able to do upon successful completion of the course.

The course syllabus states that students completing the course successfully will be able to (among other things):

- *Prepare technical reports*
- *Make formal oral presentations*
- *Use Microsoft Word, Excel, and Power Point as tools to analyze, report, and present data*

Previous focus was on the mechanics of using the software to produce technical reports as well as on the content of the reports, with a quick and brief coverage of the parts of a technical report. In fact, students were given a template identifying the parts of a technical report and told to complete each part. A brief introduction to the various parts of the report was provided, but little time was spent discussing the function and content of each part of the technical report. The former learning objectives for the course stated:

*Students completing this course will be able to*

- *Use technology to produce a technical report*
- *Include appropriate content in the report*
- *Organize the report content according to a standard template*

While the overall course objectives remained the same, the new focus of the instruction emphasized the parts of a technical report and the purpose and appropriate content of each, the use of appropriate sources to gain information, and how to cite sources and avoid plagiarism. Operationally, the following learning objectives were added as “sub-objectives” to the “preparing technical report” student learning outcome:

*Students completing this course will be able to:*

- *List, identify, and appropriately produce the various parts of a technical report*
- *Find and use appropriate STEM databases of sources (including books, journal articles, and websites) to gather the information to be used in their report*
- *Identify the parts of a citation and correctly cite sources of information used in their report*
- *Avoid plagiarism*

## 2.2 Grading Rubrics

Since the student learning outcomes were revised, the technical report grading rubrics were modified to include the new emphases of instruction. In addition to the basic organization, grammar, spelling, length, and adherence to guideline elements, the new grading rubric includes each part of a technical report and describes criteria for the various achievement levels for each part. The achievement levels (points) for each item are: 1 – Not Acceptable; 3 – Below Expectations; 5 – Meets Expectations; and 6 – Exceeds Expectations. For example, the “Meets

Expectations” criteria for the “References” element include the following description: “correct, consistent format; all references cited; wide variety of sources cited to show breadth and depth in research.”

The nine (9) primary engineering course instructors utilized the new grading rubric in evaluating and grading the technical reports. Students were given the technical report grading rubric at the beginning of the project so they could use the rubric as a guide as they were writing their reports. They were encouraged to “self-grade” the report and make any changes to improve their results before handing in the final version of the technical report to their instructor. Instructors used the same rubric to assign grades for the technical reports.

A copy of the complete technical report grading rubric is presented in Appendix A.

### **3.0 Assessment**

Since this project is the initial stage in incorporating information literacy into the first year curriculum, there are no previous groups for comparison with the pilot group of students. The integration of the information literacy component was assessed by evaluating the level of mastery of topics presented. The assessment was done through a series of pre- and post-tests, in-class activities, out-of-class assignments (research paper and technical reports), and qualitative student surveys.

#### **3.1 Pre- and Post- Test Results**

Pre- and post-quizzes were designed for each of the major topics presented by the Librarians during each of the three Information Literacy class sessions. These quizzes were uploaded to the course management system for each course section. Unfortunately, the quizzes did not comprise a significant enough part of their overall course grade, so many students did not complete all of them. Pre-tests were not counted at all, so many students just ignored them. No section of the course provided sufficient data for valid comparison of pre-post data. Since these were the only on-line quizzes administered, perhaps the students didn’t realize the importance of taking the quizzes. While the librarians sent email message to students to remind them to complete the quizzes, those messages were not taken as seriously as they should have been. Students seemed to view the librarians as guest speakers, rather than teaching partners. This issue needs to be addressed in future implementations of these modules within the course.

#### **3.2 Student Activities and Assignments**

Students were given short in-class activities to reinforce information literacy content taught. For example, one of the in-class activities given by the librarians required students to identify the various types of sources (including specific journal articles, websites, books, and other media) from articles presented, as well as locate information on a specific topic using library resources, such as Summon, Engineering Village and other STEM search engines and databases. During the in-class activities, students were given real-time feedback and it was evident that they learned the material in an iterative pattern.

Out-of-class assignments were focused on topics and themes related to and supportive of their larger class projects. Most of these activities were shortened activities designed to be combined with other assignments to comprise the background and literature review section of their project

technical report. The results of several of these activities were synthesized to create the final Background and Literature Review sections of their project technical report. Many of the activities required individual effort which was later combined with other individual student work to create a group product. Each of these focused activities was designed to systematically step students through the literature review process.

For example, as part of their first project, students were required to individually write a research paper on three basic types of bridges. They were required to cite at least ten references, with three references being books and two being peer-reviewed articles. In the technical report for the final project, citation requirements included a patent where necessary and a handbook. In this case, faculty evaluated students' understanding from their research papers and the technical reports. In-class discussions on the graded research papers and technical reports were very insightful as they highlighted the fact that students were learning the material. Students learned from comments on each others' reports and faculty learned what topics they needed to clarify in the next iteration to better facilitate student learning.

### **3.3 Students' Technical Reports**

Students were required to write two research papers and two technical reports, one of each for the first and final design. The new grading rubric (appendix A) that was used was designed specifically to measure the new student learning outcomes and to assess the overall quality of students' technical reports by evaluating: the appropriate content for each of the parts of the technical report, appropriate differentiation of the content of each section; correct and appropriate citation of sources; and the use of acceptable sources.

Unsolicited feedback from instructors who taught the course this year and in previous years indicated that the overall quality of the technical reports was better this year than in previous years. While faculty noted that there was significant improvement in the overall quality of the students' research papers and technical reports compared to previous semesters, there were some common issues. On the research paper, typical issues were:

1. Inconsistencies with the citation format. Standard MLA referencing conventions were required and in many cases links to websites were included in the reference list without appropriate MLA formatting.
2. Missing in-text citations.
3. Citing less than the minimum number and missing some requisite references due to lack of understanding of how to strategically search for information.
4. Not comfortable using online campus library resources.

The average score on the first research paper was 83%, indicating that most of the students reached a reasonable level of mastery of these concepts and were able to implement what they learned effectively.

On the first technical report, the most common student issues were: (1) not exceeding the minimum number of citations, and (2) a lack of variety in the citations. Of the minimum number of citations requested, students were asked to include a certain number of citations from specific sources (books, e-books, peer-reviewed journal articles, etc.). Once the students met those requirements, they invariably cited websites for all the other sources. On the final technical

report, the major problem was not exceeding the minimum number of citations. The average scores on the first and final technical reports were 87% and 92% respectively. These scores indicate a reasonably high level of mastery of the technical report elements graded.

### **3. 4 Qualitative Surveys**

Student feedback on the information literacy component of the course was solicited to get information on students' perceptions of the integration. The overall reaction was positive. When asked what was most beneficial about the information literacy sessions, students' comments included:

- being able to glean information faster with a focused research strategy
- being cognizant of the various information sources other than the internet
- the ability to access library resources without physically going to the library

On what was least beneficial, students commented on the difficulty in remotely accessing information via the library webpage.

No official faculty surveys were done. However, in meetings and dialogues about the new content, it was agreed that there were noticeable improvements in the quality of the technical reports when compared to previous years.

### **4.0 Conclusions & Recommendations**

Based on student and faculty feedback, the infusion of Information Literacy into the Engineering Problem Solving I course was successful and worth repeating in future semesters. It was evident that students learned how to locate and use appropriate sources for engineering research, how and when to cite their sources, and were able to apply what they learned as they wrote their technical reports. Faculty feedback indicated an improvement in technical reports this year over previous years.

While there were benefits to the Information Literacy infusion, there are several issues that must be addressed in future implementations. First, the pre- and post- quizzes on each teaching module must be better integrated into the course so students know they must complete them. Second, librarians must be seen as teaching partners for the course, rather than occasional guest speakers. Instructors must show support of the librarians as part of the course teaching team. Third, the Information Literacy content was added to the curriculum and nothing was removed. Therefore, some of the classes seemed rushed at the end of the semester in order to get all the original content covered. Suggestions for addressing this issue include: (A) reducing the number of in-class session to two and implementing on-line teaching modules with presentation content, quizzes and assignments; or (B) using a combination of one in-class session, one on-line module, and one general presentation as part of the Freshman Engineering "Out of Class Experience" Program that each student must attend. Other options will be explored as well. Fourth, there were several issues relating to efficient use of the course management system and communication among students, faculty, and librarians. Addressing each of these issues are expected to help us track student performance more precisely, improve student learning of information literacy concepts, and ultimately result in students who enter their engineering majors with the requisite skills set on writing high quality technical reports.

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**APPENDIX A  
FRESHMAN ENGINEERING  
RUBRIC FOR TECHNICAL REPORTS**

<b>Attribute:</b>	<b>1 - Not Acceptable</b>	<b>3 - Below Expectations</b>	<b>5 - Meets Expectations</b>	<b>6- Exceeds Expectations</b>	<b>Score</b>
<b>Report Mechanics</b>					
Organization	inappropriate content in most sections of report	inappropriate content in few sections of report	content appropriate to all sections of report	unique organization enhances readability and understandability of report	
Format	too many format errors so as to make report useless	few format errors	given format followed		
Spelling	any spelling errors	words with different spellings for the same pronunciation	no spelling errors		
Grammar and Punctuation (G&P)	first person used, inappropriate use of passive and active voice & past and present tense, too many G&P errors	few G&P errors	written in third person, appropriate use of passive and active voice & past and present tense, no G&P errors		
Length	far too long/short	too long /short	appropriate length		
Complete "Story" Told	very incoherent and incomplete - no story told	some sections incomplete -aspects of story missing	coherent and complete - story told	additional material enhances quality of report	
Aesthetics	unacceptable – e.g. fonts difficult to read, tables and figures hard to understand	some sections difficult to read	text, tables, figures readable and understandable		

<b>Attribute:</b> <b>Content</b>	<b>1 - Not Acceptable</b>	<b>3 - Below Expectations</b>	<b>5 - Meets Expectations</b>	<b>6 - Exceeds Expectations</b>	<b>Score</b>
Cover Page	vague , nondescript title (e.g. title simply states "sample report/project), other components missing (e.g. submission date, course and section number)	vague title, some components missing	title is brief, descriptive and relevant all components clearly stated		
Abstract/ Executive Summary	problem not stated, conclusion not summarized, only states what was done	problem not clearly stated, significant results not included	problem and significant results clearly stated, conclusion summarized	very clear and complete so as to enhance impact of report	
Table of Contents	incorrect alignment of headings, subheadings and page numbers, page numbers not included or written as "page #"	misalignment in some sections	appropriate alignment of headings, subheadings and page numbers, appropriate indentation of subheadings	very clear and complete so as to enhance impact of report	
List of Figures / Tables	page numbers not included or incorrect, identifying numbers and descriptive captions missing or incomplete, misalignment with page numbers	few misalignments, minor errors with page numbers	identifying numbers, descriptive captions and all figures/tables included, correctly numbered and appropriately aligned	very clear and complete so as to enhance impact of report	

Introduction	need for and benefit of work not explained,  no connection with problem,  no reference to background information or too much background information,  inappropriate content- (e.g. results, conclusions), constraints not explained	vague or incomplete explanation of need and benefit of work,  poor connection with problem,  insufficient background information,  limited explanation of constraints	need and benefit of work clearly stated,  clear connection with problem,  brief background information,  constraints clearly explained	very clear and complete so as to enhance impact of report	
Background	irrelevant information, personal interpretation of information	little irrelevant information included	clear and relevant information	very clear and complete so as to enhance impact of report	
Problem Statement	unclear, too long, inappropriate content	unclear or incomplete	clearly and concisely stated	very clear and complete so as to enhance impact of report	
Methodology	results included and/or discussed, specific codes from specific software included	unclear or incomplete	clearly stated, all assumptions included	very clear and complete so as to enhance impact of report	
Results and Discussion	no results included no explanation of data collection, verification and analysis, for design reports-no optimizations presented and explained	unclear results, unclear explanations, few optimizations stated with little or no explanation	clear explanations, optimizations presented and explained	very clear and complete so as to enhance impact of report	

Conclusions and Recommendations	not stated, includes ideas not discussed in report	weak, includes ideas not discussed in report, includes wishes/desires rather than recommendations	clearly stated, meaningful recommendations	very clear and complete so as to enhance impact of report	
References	incorrect/inconsistent format, not cited in report	some references missing, incorrect/inconsistent format, no variety in sources	correct, consistent format, all references cited, wide variety of sources cited to show breadth and depth in research		
Appendix	contains material that should be in the body of report or vice versa	not clear and easy to follow, appropriate location	clear and easy to follow appropriate location, referred to in the body of report		
<b>Use of software features to prepare written report</b>		ineffective	effective		