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Robin Hensel is the Assistant Dean for Freshman Experience in the Benjamin M. Statler College of Engineering and Mineral Resources. She holds a B.S. in mathematics from Wheaton College IL, an M.A. in mathematics from SUNY at Buffalo, and an Ed.D. from West Virginia University. Before WVU, Hensel worked for the U.S. Department of Energy as a Mathematician and Computer Systems Analyst, and as an Associate Professor and Department Chair at Salem International University. Her research interests include STEM education at all levels, first-year experience and issues related to the transition from high school to college, and the retention and recruitment of women and minorities to STEM fields.

Ordel Brown Ph.D., West Virginia University

Ordel Brown, Ph.D., is a Teaching Assistant Professor in the Statler College of Engineering and Mineral Resources at West Virginia University. She currently teaches first-year courses in the Freshman Engineering program, and her research interests include the identification of variables that impact the recruitment, the first-year experience and retention of underrepresented populations in STEM fields, and the development of strategies to increase their persistence.

Ms. Mary L. Strife, West Virginia University

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.
1.0 Introduction and Background
Technical writing is an essential skill for all developing and practicing engineers.\textsuperscript{1,2} 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.\textsuperscript{3-5} The current information driven environment requires engineering students and graduates to be able to find, evaluate and use information effectively.\textsuperscript{6-9} This process includes: performing literature reviews to find needed information from appropriate, credible sources\textsuperscript{10}, 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\textsuperscript{11,12} but provide high quality examples of various types of technical communication\textsuperscript{13}.

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\textsuperscript{14,15} 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.
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.
References


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

<table>
<thead>
<tr>
<th>Attribute: Report Mechanics</th>
<th>1 - Not Acceptable</th>
<th>3 - Below Expectations</th>
<th>5 - Meets Expectations</th>
<th>6- Exceeds Expectations</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>inappropriate content in most sections of report</td>
<td>inappropriate content in few sections of report</td>
<td>content appropriate to all sections of report</td>
<td>unique organization enhances readability and understandability of report</td>
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<tr>
<td>Format</td>
<td>too many format errors so as to make report useless</td>
<td>few format errors</td>
<td>given format followed</td>
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<td>Spelling</td>
<td>any spelling errors</td>
<td>words with different spellings for the same pronunciation</td>
<td>no spelling errors</td>
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<td>Grammar and Punctuation (G&amp;P)</td>
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<td>few G&amp;P errors</td>
<td>written in third person, appropriate use of passive and active voice &amp; past and present tense, no G&amp;P errors</td>
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<td>Length</td>
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<td>too long/short</td>
<td>appropriate length</td>
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<td></td>
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<tr>
<td>Complete “Story” Told</td>
<td>very incoherent and incomplete - no story told</td>
<td>some sections incomplete -aspects of story missing</td>
<td>coherent and complete - story told</td>
<td>additional material enhances quality of report</td>
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</tr>
<tr>
<td>Aesthetics</td>
<td>unacceptable – e.g. fonts difficult to read, tables and figures hard to understand</td>
<td>some sections difficult to read</td>
<td>text, tables, figures readable and understandable</td>
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<td></td>
</tr>
<tr>
<td>Attribute: Content</td>
<td>1 - Not Acceptable</td>
<td>3 - Below Expectations</td>
<td>5 - Meets Expectations</td>
<td>6 - Exceeds Expectations</td>
<td>Score</td>
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<td>title is brief, descriptive and relevant all components clearly stated</td>
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<td>Abstract/Executive Summary</td>
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<td>problem not clearly stated, significant results not included</td>
<td>problem and significant results clearly stated, conclusion summarized</td>
<td>very clear and complete so as to enhance impact of report</td>
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<td>Table of Contents</td>
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<td>misalignment in some sections</td>
<td>appropriate alignment of headings, subheadings and page numbers, appropriate indentation of subheadings</td>
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<td>List of Figures / Tables</td>
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<td>few misalignments, minor errors with page numbers</td>
<td>identifying numbers, descriptive captions and all figures/tables included, correctly numbered and appropriately aligned</td>
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<td>Issues</td>
<td>Needs clearly stated, connection with problem, clear background information, constraints clearly explained</td>
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<td>Background</td>
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<td>Methodology</td>
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<td>all assumptions included</td>
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