Using Direct Information Literacy Assessment to Improve Mechanical Engineering Student Learning - A Report on Rubric Analysis of Student Research Assignments

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Abstract

This quasi-experimental study examined the effectiveness of library instruction in a junior level mechanical engineering design process course during the Spring 2013 and Fall 2013 semesters. In the Spring of 2013 librarians delivered an active learning session to students, placing heavy emphasis on the breadth of information resources available for engineering design research beyond what can be found through Google. The session was designed to build on university general education information literacy outcomes. Student research assignments completed after the library session were analyzed using an information literacy rubric. Based on the results, librarians collaborated with the course instructor to modify the Fall 2013 library session to place the heaviest emphasis on search strategy development, rather than the breadth of information resources, and adapt the research assignment requirements. The revised session also aligned with the Searching as Strategic Exploration frame of the ACRL Framework for Information Literacy. Student assignments were again analyzed after the Fall 2013 session. The results showed a positive association between the revised instruction and assignment and rubric scores. Making changes to the library instruction and assignment based on assessment results helped to ensure that librarian and course instructor time spent preparing course assignments and delivering the session material was being spent most efficiently.

Introduction

Michigan Technological University is a four year, public research university with just over 7,000 students. Nearly 65% of the university’s undergraduates are enrolled in the College of Engineering. Librarians and faculty working with third year Mechanical Engineering-Engineering Mechanics students in the course Engineering Design Processes observed that student bibliographies for design projects were often brief, utilized the minimum required number of sources, were incomplete, or featured non-academic resources, such as sales websites. Thus, librarians and faculty at Michigan Tech collaborated to first modify, assess, and then improve library instruction interventions within this course.

The Engineering Design Processes course culminates in a simulated design project in which students work in teams to research and develop a solution for an assigned design problem. Examples of design problems include development of an ergonomic fishing rod for people with arthritis and a more effective design of robots used for rescue situations. Near the beginning of the project, student team members complete a background research assignment in which each student researches a different aspect of the problem (e.g. constraints, stakeholder needs, social impact, etc.) and writes a brief overview. Librarians have been involved with this course and offering library instruction to support the background research assignment since 2010. However,
both librarians and faculty noticed that problems persisted with student bibliographies and so collaborated to develop a new in-person library instruction session and an assignment. Both interventions would on build on previously existing skills from general education, expand awareness of engineering information resources, and improve the quality of students’ background research.

These modifications were implemented in Spring 2013 and then assessed via rubric. This approach was chosen as it aligned closely with a university-wide assessment initiative that designated information literacy as one of eight undergraduate student learning goals. Each learning goal, including information literacy, is supported by a rubric and assessed regularly both in General Education and by individual departments. The rubric used in the assessment of *Engineering Design Processes* was not the university rubric for Information Literacy, but was quite similar (see Appendix A). Both rubrics were based on the *AAC&U LEAP Value rubric for Information Literacy*¹ and modified based on *ACRL’s Information Literacy Standards for Science and Engineering/Technology*².

Based on the data collected after the Spring 2013 library session, it became clear that students were continuing to struggle in their search for quality information sources. During Summer 2013, librarians and instructors further revised the information literacy interventions offered for the course. In addition to being informed by the data collected, these changes aligned closely with the *Searching as Strategic Exploration* frame of the newly developed *ACRL Framework for Information Literacy*³, which highlights the idea that the search for information is non-linear and requires flexible searching skills. Ideally, by focusing on the development of search strategies, students would develop a wider, more flexible range of skills to apply when seeking information for their design projects.

These changes were implemented in Fall 2013 and student work products were assessed at the conclusion of the semester with the same rubric used for assessment in Spring 2013. Librarians found that focusing library instruction heavily on improving search skills showed a much higher percentage of students using quality resources in their bibliographies. These gains highlight the importance of reflection and continuous improvement within the process of information literacy instruction, assessment, and revision.

**Literature Review**

Information literacy skills are vital for undergraduate students and particularly critical in the engineering design process⁴,⁵,⁶. To be successful the design process requires students to identify the scope of a project’s information needs, find quality research and information that both informs and contextualizes the project, synthesize that information, and then develop a design
based on it. Past studies have highlighted engineering students’ and new graduates’ limited ability to define the scope of their information needs and then find quality, in-depth research to support their assignments and projects. In fact, Project Information Literacy found that recent graduates across fields often enter the workforce with a strong ability to use search engines to find quick answers, but often lack the ability and perseverance to go beyond quick fact-finding using basic information resources.

Due to these needs and challenges, it is vital that librarians continuously assess and improve the information literacy instruction offered to undergraduate engineering students. To this end, librarians working with engineering students have relied on a variety of assessment methods to determine the impact of their instruction including pre- and post-tests, citation analysis of design projects, rubrics, and student surveys.

For our assessment, rubrics were the preferred tool both because they are widely used in university-wide assessment, including that of information literacy, and because they offer a number of advantages over other assessment methods. These include the ability to gather more nuanced, qualitative information on each stage of the information seeking process (as represented by detailed criteria of the rubric lines), a focus on students’ achievement of agreed upon learning outcomes, standardized norming of scores across assessors, and lower cost, both in terms of student time and cost to administer. Potential drawbacks to rubrics include the impact of raters’ experiences on their scoring, rater training, changes in rater severity over time, and poor rubric design. However, we felt that these drawbacks could largely be addressed with careful planning and training throughout the process.

There are many instances in the literature of modifying information literacy instruction for engineering students after assessment. Modifications are often done in the specific context of the given course, student level, instructor, and institution that the librarian is working within. In addition to modifying our instruction based on our assessment results and our given context, we also took into consideration the ACRL Framework for Information Literacy. This document outlines key threshold concepts, or core ideas that change a learner's perspective on a discipline like information literacy. Within this framework, we chose to focus on the concept of Searching as Strategic Exploration, which posits that:

… information searching is often nonlinear and iterative, requiring the evaluation of a broad range of information sources and the mental flexibility to pursue alternate avenues as new understanding is developed (10).

This concept aligns closely with the observed gap in engineering students’ and new graduates’ information seeking skills. Because the Framework for Information Literacy is newly developed, our instructional modifications are a concrete example of how information literacy in the engineering classroom can be addressed in the context of the new framework.
Participants

Students in the *Engineering Design Processes* course, which is required in the Mechanical Engineering-Engineering Mechanics Department, are mechanical engineering majors, most of whom are in their junior year. These students have had instruction in and practice with information literacy skills and concepts previously in their first-year General Education courses and in a required Engineering Fundamentals course which all engineering majors take in their first year. Most of these students do not encounter any in-person information literacy instruction in their engineering courses between their first year and the *Engineering Design Processes* class in their junior year, although in their sophomore year they are required to view a librarian-produced “searching for standards” tutorial and then find a standard on their own in order to complete a lab report.

There was no randomization or sub-sampling involved in this study; every student in the *Engineering Design Processes* course who turned in an assignment was assessed.

Process

Table 1 summarizes the differences between the Spring 2013 and Fall 2013 library sessions and course assignments. See Appendix B for full details of the lesson plans for the Spring and Fall 2013 semesters.

**Table 1. Library Session and Assignment Differences Spring 2013-Fall 2013**

<table>
<thead>
<tr>
<th>Library Session Activities</th>
<th>Spring 2013</th>
<th>Fall 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Focused on difference between Google and Library databases (ENGnetBASE and Compendex).</td>
<td>● Increased length of session from 60 minutes to 90 minutes.</td>
</tr>
<tr>
<td></td>
<td>● Students searched for “fishing rod design” in each resource and answered four evaluative questions about the results.</td>
<td>● Students read short case study and defined information need.</td>
</tr>
<tr>
<td></td>
<td>● Ended with 20-minute segment on patent searching.</td>
<td>● After defining information need, developed search strategies in groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● Tried search strategies in Compendex, then evaluated and modified strategies.</td>
</tr>
</tbody>
</table>
| Assignment Details | ● Write background research summary, using 3-5 sources and IEEE citation style.  
● Include bibliography.  
● Include research log detailing resource searched, search strategy, and evaluation of results (see Appendix B). | ● Write background research summary, using 10-15 sources and IEEE citation style.  
● Include bibliography.  
● An “example paper” was added to the CMS so students could see good synthesis and citation in practice. |

Spring 2013 Instruction & Assignment
The Spring 2013 library instruction session included group activities that explored the types of information sources that could be found using ENGNetBASE, Compendex, and through a basic United States Patent and Trademark Office (USPTO) search. The focus was primarily on what content types could be found in these sources and when they might be appropriate to use during the engineering design process. Comparisons between types of content that can be found in the engineering-focused sources, as opposed to only searching Google for a topic, were included. Little time was spent on developing more complex strategies to search the engineering focused resources, as it had been assumed that much of the search skills foundation was built through library instruction in earlier general education courses. In the week following the library session, students researched one aspect of their design problem and wrote a brief background information report with 3-5 cited references.

Spring 2013 Assessment
After the library instruction session, research logs and background research reports including bibliographies from 111 students were assessed. Of these, 106 of the students had attended the library session. Prior to the first round of assessment conducted after the Spring 2013 library session, librarians modified the university-level information literacy rubric to be applicable to the Engineering Design Processes assignment. Both the university-level rubric and the rubric modified for this study are included in Appendix A. The four librarians conducting the assessment then participated in a norming session to ensure that all assessors would be applying the rubric consistently. The rubric consisted of three information literacy criteria: accessing needed information, using information effectively, and accessing and using information ethically. Scores ranging from 1-4 can be assigned for each of the three criteria according to the rubric, with situations in which a 0 would be assigned defined during the norming session and noted on the rubric.
Identifying information, including name, group number, and course section number, was removed from the assignments and replaced with a code by a staff member who did not participate in assessment. Each of four librarians who participated in the assessment process was then assigned a subset of the coded papers. Each paper was assessed only once. Librarians scored the student work products assigned to them within two weeks after the norming session.

Fall 2013 Instruction & Assignment
Prior to the beginning of the Fall 2013 semester, two librarians met with the course instructor and discussed changes to be made to the information literacy instruction based on the results from the Spring 2013 assessment.

Based on this information, modifications were made to the Fall 2013 library instruction session to focus more heavily on developing students’ database searching skills. The revised active learning session involved thinking through a single aspect of an engineering design problem, developing potential keywords and synonyms, creating and revising database search strategies, and evaluating results for relevance. Students received hands-on practice with one engineering-focused resource, Compendex. The component related to comparing results from engineering databases to Google results was removed.

In addition, changes were made to the Fall 2013 course assignment. The changes included 1) removing the research log requirement at the request of the instructor to reduce student work loads, 2) adding an example literature review to the course website, and 3) increasing the required number of citations from 3-5 to 10-15.

Fall 2013 Assessment
Background research reports from 49 students were assessed using the same rubric as was used in Spring 2013 (with the number of citations in the Access and Use Information Ethically criteria increased to reflect the modified assignment). Of these 49, all had attended the library session. The Engineering Design Processes course typically has a higher enrollment in the spring semester than in the fall semester, hence the discrepancy in the number of assignments assessed.

The same methods for anonymizing and assessing the submissions used in the Spring assessment was used in the Fall.

The norming session was not repeated in Fall 2013 because the rubric being used was the same as in spring and all three of the librarians assessing student work had participated in the spring. Librarians scored the student work products assigned to them within two weeks of receiving the assignments.
Results and Discussion

Table 2 displays the frequencies and relative frequencies of scores generated from the rubric assessment of the Spring 2013 assignments (see Appendix A for the assignment rubric). The modes of the data were scores of 2 for both the criteria Access Needed Information (39%) and Use Information Effectively (41%), and a score of 3 for the Use Information Ethically (58%) criterion.

Table 2. Spring 2013 Frequencies and Relative Frequencies

<table>
<thead>
<tr>
<th>Rubric Score / Criteria</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Needed Information</td>
<td>7</td>
<td>41</td>
<td>43</td>
<td>16</td>
<td>4</td>
<td>n=111</td>
</tr>
<tr>
<td></td>
<td>(6%)</td>
<td>(37%)</td>
<td>(39%)</td>
<td>(14%)</td>
<td>(4%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Use Information Effectively</td>
<td>5</td>
<td>20</td>
<td>45</td>
<td>28</td>
<td>13</td>
<td>n=111</td>
</tr>
<tr>
<td></td>
<td>(4%)</td>
<td>(18%)</td>
<td>(41%)</td>
<td>(25%)</td>
<td>(12%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Use Information Ethically</td>
<td>3</td>
<td>23</td>
<td>7</td>
<td>64</td>
<td>14</td>
<td>n=111</td>
</tr>
<tr>
<td></td>
<td>(3%)</td>
<td>(21%)</td>
<td>(6%)</td>
<td>(58%)</td>
<td>(12%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

As described in the “Process” section, librarians and the course instructor reviewed the spring results to determine what could be improved for the Fall 2013 instruction sessions. The data indicated the weakest criteria was Access Needed Information. 18% of spring students scored a 3 or a 4 on this criteria, whereas 37% of students scored a 3 or a 4 on Use Information Effectively, and 70% of students scored a 3 or a 4 on Use Information Ethically.

Table 3 shows the frequency and relative frequency results of the Fall 2013 rubric assessment. The modes were a score of 4 for Access Needed Information (41%), a score of 2 for Use Information Effectively (31%), and a score of 3 for Use Information Ethically (55%). No scores of 0 were reported for any of the three criteria.

Table 3. Fall 2013 Frequencies and Relative Frequencies

<table>
<thead>
<tr>
<th>Rubric Score / Criteria</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Needed Information</td>
<td>0</td>
<td>3</td>
<td>11</td>
<td>15</td>
<td>20</td>
<td>n=49</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(6%)</td>
<td>(22%)</td>
<td>(31%)</td>
<td>(41%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>
The criterion the Fall 2013 library instruction focused most heavily on was Access Needed Information. Figure 1 shows the relative frequencies of the spring and fall scores with regard to this criterion.

**Figure 1. Relative Frequencies by Term - Access Needed Information**

![Relative Frequencies by Term - Access Needed Information](image_url)

Figures 2 and 3, respectively, show the relative frequencies of the spring and fall scores for the criteria Use Information Effectively and Use Information Ethically.
Figure 2. Relative Frequencies by Term - Use Information Effectively

Figure 3. Relative Frequencies by Term - Use Information Ethically
In Fall 2013, 72% of students scored a 3 or a 4 on *Access Needed Information*, 49% of students scored a 3 or 4 on *Use Information Effectively*, and 67% scored a 3 or a 4 on *Use Information Ethically*. In comparison, in Spring 2013, 18% of students scored a 3 or a 4 on *Access Needed Information*, 37% of students scored a 3 or a 4 on the *Use Information Effectively*, and 70% of students scored a 3 or a 4 on the *Use Information Ethically* (Table 2).

Using the modified library instruction approach and assignment, scores pertaining to accessing the needed information were substantially higher than with the Spring 2013 instruction and assignment design. Additionally, higher scores were observed pertaining to using information effectively and slightly decreased scores were seen with regard to using information ethically.

The data trends show an apparent positive association between the modified instruction and assignment delivered to Fall 2013 students and their resulting scores. Increased scores were observed pertaining to the criteria targeted for improvement, *Accessing Needed Information* (54% difference). The other two criteria, *Using Information Effectively* and *Using Information Ethically*, were not targeted specifically with the modified approach. However, increased scores were observed in *Using Information Effectively* (12% difference) and a slight decrease in *Using Information Ethically* (-3% difference) scores. It does not appear the substantial increase in the primary area of focus, accessing information, was detrimental to the other two areas assessed.

**Limitations**
The quasi-experimental study conditions, without participant randomization, are not ideal for examining causation between library instruction and student scores, or generalizing the results to a larger population of engineering students.

**Potential confounding variables**
Spring vs. Fall students - The fall term of a student’s junior year is the term the *Engineering Design Processes* course is planned for completion by the academic department in an ideal sequence. It is possible the students completing the course in the fall term, as planned, are inherently stronger than those students who are off sequence, completing the course in the spring session. However, we believe the many other reasons engineering students end up off sequence, such as co-ops, internships, changing majors, schedule selection, etc, help mitigate this concern.

Self-assessment - Four librarians completed the rubric assessment in the Spring 2013 term. Of these four, three completed the Fall 2013 rubric assessments. These librarians were the same librarians who delivered the library instruction to students. Ideally, librarians who did not deliver the instructional component would perform the rubric assessment. However, due to staffing levels this was not possible. However, there is evidence that grouped-self assessment (our process) can be valid\(^{17,18}\).
Assessment rating period - A norming/calibration session was held for librarian raters prior to the Spring 2013 assessment. Notes were taken and supplied to assessors for use during both the spring and fall assessment periods. Due to time constraints, scoring was conducted over a period of two weeks. Previous studies have shown mixed results in the consistency of raters over time. Two studies showed increased severity in ratings over time post calibration\textsuperscript{19, 20}, while another showed increased leniency over time\textsuperscript{21}. One study did not show a drift in the consistency of ratings applied over time, on average for assessors\textsuperscript{22}.

**Conclusion**

The process of librarians using rubrics to assess components of information literacy in a junior-level mechanical engineering course and collaborating with the course instructor to make improvements to the library session and research assignment appears to show a positive impact on student learning.

Librarians found that 54% more students used a higher proportion of quality resources in their bibliographies, as demonstrated by the improvements in the *Access Needed Information* criterion (72% vs 18%) when they 1) experienced library instruction focused heavily on improving search skills in one database (Compendex) vs. instruction on multiple databases without a specific emphasis on search strategies, 2) were provided with an example that showed evidence of good synthesis and citation in practice, 3) were required to use 10-15 sources in their assignment, as opposed to 3-5, and 4) experienced a 90 minute library session vs. a 60 minute session.

Both the course instructor and librarians were satisfied with the results - more complete bibliographies that incorporated higher quality sources and better insight into the topic researched.

The modified library instruction approach is an example of a practical application of the *Searching as Strategic Exploration* frame of the *ACRL Framework for Information Literacy*\textsuperscript{3}. The revised lesson plan incorporated the following knowledge practices from this frame:

- “determine the initial scope of the task required to meet their information needs”
- “utilize divergent (e.g., brainstorming) and convergent (e.g., selecting the best source) thinking appropriately when searching”
- “match information needs and search strategies to search tools”
- “design and refine needs and search strategies, based on search results”
- “use different types of searching language (e.g., controlled vocabulary, keywords, natural language) appropriately”
The rubric assessment process implemented has enabled librarians and the course instructor to take an in-depth look at the effectiveness of the information literacy approach. This has helped to ensure that student and librarian time are being spent most efficiently and with the greatest impact. For continuous improvement ongoing assessments and modifications to the library instruction session and related student assignments are planned (e.g. a resources type awareness and recognition quiz). Also, librarians would like to collaborate further with the engineering departments to apply information literacy rubric analyses to capstone senior design projects. This would inform librarians, faculty members, and other stakeholders as to how students are able to apply the information literacy knowledge and skills gained in previous courses with an open assignment that does not include library instruction or significant guidance through structured requirements.

References


## Appendix A: Rubrics

**University Student Learning Goal 6: Information Literacy Rubric**

<table>
<thead>
<tr>
<th>Information Literacy</th>
<th>What is being assessed</th>
<th>Beginning 1</th>
<th>Developing 2 - CORE 2000</th>
<th>Proficient 3</th>
<th>Exemplary 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.1 Determine the Extent of Information Needed</strong></td>
<td>Recognizes the need for information and divides that need into researchable subtopics.</td>
<td>Has difficulty identifying an information need.</td>
<td>Identifies an information need but has difficulty dividing that need into researchable subtopics.</td>
<td>Identifies an information need and demonstrates an ability to divide that need into mostly relevant, researchable subtopics.</td>
<td>Identifies an information need and demonstrates an ability to divide that need into relevant, researchable subtopics.</td>
</tr>
<tr>
<td><strong>6.2 Access the Needed Information</strong></td>
<td>Knows how (strategies) and where (information outlets) to search for information.</td>
<td>Accesses information non-strategically and from few relevant information outlets.</td>
<td>Accesses information using simple search strategies and from few relevant information outlets.</td>
<td>Accesses information using sophisticated search strategies and from some relevant information outlets.</td>
<td>Accesses information using effective, well-designed search strategies and from most relevant information outlets.</td>
</tr>
<tr>
<td><strong>6.3 Evaluate Information Sources Critically</strong></td>
<td>Uses criteria to select sources that are appropriate to the information need.</td>
<td>Chooses sources using undetermined or inappropriate criteria.</td>
<td>Chooses sources using somewhat appropriate but minimal criteria.</td>
<td>Chooses sources using an appropriate selection of criteria.</td>
<td>Chooses sources using an effective selection of criteria that are most appropriate to the scope of the information need.</td>
</tr>
<tr>
<td><strong>6.4 Synthesize Information to Accomplish a Specific Purpose</strong></td>
<td>Represents and synthesizes information from sources completely and objectively to achieve intended purpose.</td>
<td>Represents information from sources but some content is missing, inaccurate and/or irrelevant to intended purpose. Begins to synthesize information from multiple sources.</td>
<td>Represents information from sources and content is present, fairly accurate and relevant to intended purpose.</td>
<td>Represents information from sources and content is complete, accurate, and relevant to intended purpose. Adequately synthesizes information from multiple sources.</td>
<td>Represents information from sources and content is complete, accurate, and relevant to intended purpose. Fully synthesizes information from multiple sources to generate new ideas and concepts.</td>
</tr>
<tr>
<td><strong>6.5 Use Information Ethically</strong></td>
<td>Understands the need for and successful implementation of proper attribution.</td>
<td>Attribution is incomplete or inappropriate.</td>
<td>Attribution is nearly complete and mostly appropriate.</td>
<td>Attribution is complete and mostly appropriate.</td>
<td>Attribution is complete and appropriate.</td>
</tr>
<tr>
<td><strong>6.6 Access and Use Information Legally</strong></td>
<td>Understands that information access and use has legal implications.</td>
<td>No awareness of the applicable laws, regulations, and institutional policies related to the creation, access, and use of information.</td>
<td>Basic awareness of the applicable laws, regulations, and institutional policies related to the creation, access, and use of information.</td>
<td>Aware of the applicable laws, regulations, and institutional policies related to the creation, access, and use of information.</td>
<td>Aware of the applicable laws, regulations, and institutional policies related to the creation, access, and use of information. Knows how and when to consult additional legal resources.</td>
</tr>
</tbody>
</table>
Definitions/Examples:

Applicable laws, regulations, and institutional policies - such as copyright, Institutional Review Board (IRB) requirements, proprietary information requirements, complying with institution access requirements, etc.

Attribution - Use of citations and references; distinguishing between common knowledge and ideas requiring attribution. Complete attribution refers to citing all pieces of information that should be cited. Appropriate attribution refers to properly adhering to the conventions of the chosen or assigned citation style (i.e. APA, MLA, IEEE, etc).

Criteria - Such as relevance to the information need, currency, authority, audience, accuracy, quality, bias, point of view, etc.

Information - Content from any source outside of one’s own knowledge base.

Information need - The thesis, argument, assignment topic, proposition, primary question, research question, or hypothesis which drives the search for information.

Information outlet - Collection of sources (e.g. library, database, internet search engine, experts in a field, archives, etc).

Researchable subtopics - Component parts of an information need that can be researched individually.

- Example: Information need - Is this building material cost effective? Researchable subtopics: Cost of the material, alternative materials, cost of alternative materials, relevant regulations, potential environmental issues, etc.

Search strategies - An intentional and well-thought out approach to finding relevant information. In the case of database searching, the combination of key terms, phrases, and synonyms derived from researchable subtopics.

- Non-strategically - such as performing only Google searches, using only natural language searches, not refining the strategy based on results and new discoveries, etc.

- Simple - such as relevant keyword and synonym searches, simple Boolean techniques, finding an item given a citation, etc.

  - Example: simple Boolean database search - searching for: buildings AND materials, as keywords that could be found anywhere in the text of an article or a book.

- Sophisticated - such as controlled vocabulary/subject searching, proximity searching, truncation techniques, advanced Boolean techniques, cited reference searching, etc.

  - Example: proximity searching - most library databases offer a proximity feature to increase the relevancy of results, for example a search for solar near/3 energy in the engineering database Compendex would return results where “solar” and “energy” appear within 3 words.

  - Example: truncation techniques - most library databases offer truncation features to expand searches. For example using the term flex* would return articles including flex, flexes, flexible, flexibility, etc. The “*” symbol is the truncation symbol used most often in library database searching.

  - Example: advanced Boolean database search - searching for: (robot* OR autonomous vehicle*) AND underwater, as terms that could be found in the abstract or title of an article.

Source - books, journal articles, technical reports, white papers, industry standards, patents, websites, data, interviews, movies, sound recordings, etc.
Modified rubric for *Engineering Design Processes* assessment

<table>
<thead>
<tr>
<th>Determine information need</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access Needed Information</strong></td>
<td>No apparent logical search strategy, sources retrieved lack relevance or quality. OR only resource consulted was internet search engine (i.e. Google, Bing, Yahoo)</td>
<td>Accesses information using simple search strategies, retrieves some high-quality sources, or of limited variety.</td>
<td>Accesses information using effective search strategies and retrieves a range of relevant/quality sources. Demonstrates ability to refine search.</td>
<td>Accesses information using effective, well-designed search strategies and retrieves most appropriate/high quality information sources. Demonstrates ability to refine search.</td>
</tr>
<tr>
<td>Score: __________ (Score 0 if no sources cited)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Evaluate Information and Sources | | | | |
| **Use Information Effectively** | Communicates information from sources, but the information is fragmented and does not achieve intended purpose. | Organizes and communicates information from sources, but the information is not synthesized. | Communicates, organizes, and synthesizes information from sources. Intended purpose is achieved. | Communicates, organizes, and synthesizes information from sources particularly thoroughly. Intended purpose is fully achieved. |
| Score: __________ (Score 0 if submission is only a list of references) | | | | |

| Access and Use Information Ethically | Fewer than 3 references are listed or listed references are not cited in-text. | 3-5 references are listed, but not all are cited in-text. | 3-5 references are listed and all are cited in-text, but some or all are not in proper IEEE format. | 3-5 references are listed in proper IEEE format and are cited properly in-text. |
| Score: __________ (Score 0 if no references listed OR if evidence of plagiarism is found) | | | | |

**TOTAL: __________**
## Spring 2013 Lesson Plan (1 hour)

<table>
<thead>
<tr>
<th>Prep</th>
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| ● Create 3 Google docs for each session (one for Google, one for ENGNetbase, one for Compendex). Topics in documents should relate to one of the current projects. Place links to these docs in the libguide.  
● Update patent search example to relate to one of the current projects.  
● Bring Powerpoint file.  
● Meet students and instructor (or TA) downstairs to escort them to the classroom. |

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<tr>
<th>10 min – Intro &amp; Google search</th>
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| ● Welcome students  
● Explain the session’s agenda: explore some resources and strategies to help you find information sources for your team projects and for future engineering projects.  
● Open LibGuide and discuss purpose - a collection of suitable resources, organized by topic/area of research.  
● In LibGuide, on home tab under “class session links” have students open Google link for their class session.  
● Have students work through the questions with a partner. They should discuss/compare with their partner after each question: what result did you get, what’s happening, etc.  
● One person in the group, edit the document to answer the questions. They will see other groups answering at the same time. |

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<th>15 Min - Databases</th>
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| ● In course guide, on home tab under “class session links” - Have students open the ENGNetbase document link and the Compendex document link for their class session.  
● Tell students to open a 2nd window and go to the library web page and search for ENGNetbase and Compendex under databases.  
● Again, working in pairs, work through the questions on the Compendex and ENGNetbase documents, discuss after each question – what result did you get, what’s happening, etc. One person, edit the document |
<table>
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<tr>
<th>10 min – Discussion of Google/Databases</th>
<th>20 min - Patents</th>
<th>5 min</th>
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<tr>
<td>to answer the questions. You will see other groups answering at the same time.</td>
<td>● Review our results: ask students what are the differences in what they have found? ● Overall, how does Google compare to the library databases? ○ Google – what did you find? ○ ENGNetbase – what did you find? ○ Compendex – what did you find? • Discuss ILL and options when going over HuskyFetch ● (Optional) – Show/Discuss Invisible Web slide ● Discuss off-campus access</td>
<td>● Wrap-up ● Clear up any lingering confusions ● Show how to get help</td>
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<td></td>
<td>● (10 min) Patent Powerpoint slides (#5-#14) ● (10 min) Students work with a partner to browse and search the index to find classes/subclasses related to their topics (use USPTO classes by title and Index links in LibGuide) ● Once they identify potential classes, search in the USPTO database issued patents section <em>(Note: encourage keyword searching of database only if potential classes cannot be identified browsing by title or searching the index)</em></td>
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Spring 2013 Library Session Searching Activity

Students were asked to work with a partner and run the same search in Google, Compendex, and ENGNNetBase and then answer the questions below for each resource.

Search for *fishing rod design*

1) How many results do you get? Why might you care how many results there are?

2) What types information sources are in the results set (i.e. blogs, vendor websites, news articles, etc)? What types of situations or people might these information sources be especially good for?

3) Are the results organized? If so, how?

4) If there are too many to page through, what are your options for getting more targeted results?
# Fall 2013 Lesson Plan (90 minutes)

## Objectives:
- Describe the information needs of one aspect of an engineering design problem
- Construct keywords & synonyms for one aspect of an engineering design problem
- Develop effective search strategies for database searching
- Identify possible databases to search for relevant information

| Prep | ● Take slides on where else to search and getting help  
| | ● Link worksheet and search strategy link to Libguide  
| | ● Bring portable whiteboards  
| 1-2 min | ● Welcome & intro  
| 15 min | Defining information needs & creating keywords and synonyms  
| | ● Have students navigate to Libguide and open the Environmental/Cultural Aspect Worksheet file.  
| | ● On their own, students work through parts 1 and 2 of the worksheet.  
| 5 min | Form groups & brief discussion  
| | ● Form groups (3 people ideally but 2 if needed). Each group should have a manager (keeps eye on time), speaker (speaks on group’s behalf during class discussion), recorder (writes group’s answers on whiteboard).  
| | ● Have students briefly discuss with their group what they came up with in parts 1 and 2 - make changes and/or additions to your individual worksheets based on group discussion  
| 15 min | Search Strategy Development  
| | ● On their own, students spend 5 minutes reading through the “Developing Database Strategies” Link and constructing 1 or 2 strategies they believe will find good results (10 min)  
| | ● Now, as a group, using a portable whiteboard, compare strategies and decide on 1 or 2 strategies they believe will find good results (combine various features of group members’ strategies if they want) (5 min)  
| 20 min | Try Strategies & Discuss  
| | ● Introduce Compendex (2 min) - open from Environment & Culture tab of the LibGuide  
| | ● Ask groups to switch white boards with
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<th>Time</th>
<th>Activity</th>
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| (15 min - Try Strategies)  
(5 min – Discuss) | another group and try their strategies (10 min)  
- Note - are the results relevant? How might the strategy be modified? Does it help if they limit searches to specific fields instead of using all fields? Would date range limits help?  
- Jot down one helpful searching tip to share with classmates  
- **Speakers** - Each group share a tip (5 min) |
| 10 -13 min HuskyFetch, where else to use search strategies & getting help. | **Remind students about HuskyFetch and ILL** to access articles (show quick example - 2 min)  
- Brief discussion of source types (research articles, patents, standards, etc) that may be helpful for engineering design & where these can be searched (**slides**)  
- Discuss tutorials available on standards and patents.  
- Encourage students to explore resources listed in guide for various aspects of their engineering design problems.  
- Encourage students not abandon searching for information on aspects they think are important for their designs after 10-15 min - please use the **AskUs!** services to request help from a librarian if you get stuck and need ideas on where or how to search. |
| 5 min | Questions & wrap up |
Fall 2013 Library Session Worksheet *Environmental/Cultural Aspects*

**Engineering Design Problem:**
Your engineering firm has been approached by a major luggage manufacturer to design the next generation of moving luggage. The manufacturer feels the luggage industry has stagnated in recent years and wants to introduce something that will “wow” travelers.

You plan on conducting focus groups and interviewing travelers yourself, but the luggage manufacturer has already done some preliminary research and determined that travelers want luggage that is lightweight yet durable, easy to maneuver in crowded areas and tight spaces, and keeps belongings well-organized.

Imagine that you are on the team of engineers developing this new and innovative luggage system. What information do you need before you begin?

In thinking about any design problem, you need to consider many factors, including **environmental and/or cultural factors**.

**Part 1: Define your information needs.** Think about the realities of the environment that your product will exist in, including the people who will be using the product, as well as the physical and geographical location. List here the information needs for **environmental and/or cultural factors** that would be important to consider for this particular problem. Add as many bullet points as you need:

- *e.g.* the luggage will need to withstand a range of weather conditions without warping or being damaged - such as heat and cold, rain, etc.

**Part 2: Develop topic keywords and synonyms.** Many essential and helpful resources for
engineering design problems are not indexed by Google and cannot be discovered using an internet search engine. These resources exist in places such as library subscription databases and government resources. Natural language search techniques, such as “What fabrics are good to use for extreme weather conditions?” cannot be used to search these resources. The first step in constructing a search strategy is to develop topic keywords and synonyms.

Using the design problem described above, and the important environmental and/or cultural factors you identified, list some keywords and synonyms that you could use in a database search. Add as many bullet points as you need:

- ex. fabric - materials, cloth, textiles, fibers
Developing a Search Strategy

A search strategy is the combination of keywords and synonyms you choose and the way you connect them with AND, OR, and NOT (also known as “Boolean operators”). An example search strategy is at the end of this sheet.

To focus your search and ensure you are getting sources that combine all aspects of your topic, use AND. Adding terms with AND will give you fewer results:

car AND hydrogen AND environment will find sources that use all three of these terms.

To expand your search and find sources that use different words for the same thing, use OR. Adding terms with OR will give you more results:

car OR vehicle OR automobile will give you sources that use any of these terms, alone or in combination with each other.
To omit certain terms from your results, use **NOT**. For example, you may have done an initial search and found that many of the sources you found related to Ford. This is great, but you are interested in other car manufacturers too. You want to filter out the articles about Ford so you can only see the ones about other manufacturers.

**car NOT Ford** will discard any of the articles that mention Ford.

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Other search tips:
- Use an asterisk (*) to truncate words if you want to search for all words with that root. For example, “environment*” would search for environment, environmental, environmentalism, etc.
- Put quotes around a phrase that you want the database to search as a phrase, rather than as individual words.
- Group synonyms inside parentheses using OR between each one.

Search strategy example: using the example keywords and synonyms table on the worksheet, one search strategy might be:

**(car OR automobile OR vehicle) AND hydrogen AND environment**