Michelle Baratta, University of Toronto

Michelle Baratta has held positions in academic and public libraries, as well as a corporate setting. Her education includes a Master’s degree in Information Studies (2007) and an Honours Bachelor of Science degree (2004), both from the University of Toronto. She is currently a Reference and Instruction Librarian at the University of Toronto’s Engineering & Computer Science Library.

Alan Chong, University of Toronto

Alan Chong is a Senior Lecturer in the Engineering Communication Program at the University of Toronto. His pedagogical research is primarily in the area of the integration of Design and Communication across the curriculum.

Jason A. Foster, University of Toronto

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The Research Studio: Integrating Information Literacy into a First Year Engineering Science Course

Introduction

In this paper, we describe a set of strategies and an associated activity used to overcome the drawbacks of traditional methods that have been used to teach information literacy skills to first year engineering students. Traditional methods and models for teaching information literacy in this context have significant drawbacks that limit their efficacy in developing core competencies. Lectures on research techniques fail to take advantage of active learning strategies, creating a learning environment that is not conducive to skill development. While more active than lectures, computer lab-based research skills sessions are limited to online sources and still center primarily on the instructor. Furthermore, they are complicated by difficulties in maintaining student focus, especially when students arrive with different sets of skills. Extracurricular library-based sessions for groups of students typically only teach research skills in the abstract, lacking the immediacy afforded by sessions integrated with their classes, and are often poorly attended. Without the immediacy of an assignment and a specific topic to research, students often fail to acknowledge the relevance of the activities, and are unable to develop transferable skills.

To address these issues, engineering faculty and librarians associated with the University of Toronto, a large research-intensive Canadian university, have collaborated on the design of an activity that integrates information literacy into the curriculum and provides a more rigorous process for instruction. Key principles that informed the activity include:

1. Introducing students to the physical library and encouraging alternatives to internet search engines for information discovery;
2. Integrating the library session into the curriculum and tying it to a core assignment with clearly defined objectives and outcomes; and,
3. Developing a series of short activities that cover an important range of sources and providing scaffolding within those activities to build transferable skills.

Introducing students to the physical library is the first step to challenging their preconceptions of the research process and to building their knowledge of the information sources that are integral to engineering research and study. Placing them in physical proximity of paper journals, books, and other sources forces them to engage with the results of their research in a fundamentally different manner than they would with online sources. Second, assigning a set of deliverables that form an intermediate step in a current course assignment as exit criteria for the overall activity forces students to engage while in the session, and enables a much more direct transfer of skills and information. Finally, structuring the activity as a set of short, 20-30 minute stations that each focus on a distinct research topic promotes student focus and provides each student with a variety of research skills.

The complete activity was comprised of six stations, of which each student within a three-person engineering design team completed three stations. The focus of the stations included comparing different types of information sources for the depth and breadth of information covered,
evaluating information sources and engaging their critical thinking skills, and developing research strategies that can be used to find different sources of information.

This paper begins by providing some background on the course and library partnership. We then describe the learning objectives for the activity as a whole and for each session, and present observations taken during the activity and unsolicited feedback from students.

Praxis I: Design and Communication

Praxis I is a first year introductory design and communication course at the University of Toronto. Students in Praxis I are taught principles of engineering design and technical communication through several design projects that involve a combination of hand-on activities, secondary research, and documentation describing and assessing their conceptual designs. The teaching model in the Praxis series of courses combines large (≈ 275 student) lectures with small (≈ 27 student) semi-structured, highly dynamic and interactive sessions.

For their second design project, students are asked to develop the conceptual design for a pedestrian truss bridge crossing a small ravine in Toronto, a project that is affiliated with a first year Civil Engineering structures course. Where the structures course focuses on the technical aspects of the bridge, Praxis I focuses on other key design considerations, such as sustainability, usability, and an understanding of user and key stakeholder needs. In both their presentation of and report on their conceptual design, they are asked to:

- Present an overview of your design concept, focusing on key design decisions and features;
- Analyze the impact of the key design decisions and features on the quality of your bridge as a work of engineering design; and,
- Link engineering design criteria and stakeholders to the justification of the key design decisions and features.

Given the nature of the assignment and their novice status as bridge designers, secondary research plays a key part of the activity for two central reasons. First, research should facilitate idea generation, providing students with reference designs upon which to base their bridge concepts, design elements to include in their bridges, and an understanding of the major considerations in bridge design. Second, such sources serve as references to back up their arguments and justify their design choices. Learning how to use such sources to warrant their claims is a key learning objective for the course.

In previous iterations of Praxis I, the course instructors found students to have a limited range of research skills that are best described as “picking low hanging fruit.” That is, students were very capable of doing internet based searches in the most popular search engines, applying conventional techniques, using only search terms drawn directly from the assignment. While capable of locating books in the library system, students tended to steer clear of the physical library whenever possible, often using inferior web resources simply to avoid the “trouble” of having to physically locate a text. Such novice research techniques may have worked in high school, but their current and future engineering projects require significantly more fluency with the range of available sources.
The Praxis I instructors identified four key deficiencies in their students’ ability to conduct scholarly research:

1. An inability to develop useable search terms for effective searching in both online and library search engines, as well as a lack of knowledge of effective search techniques (such as the use of Boolean operators in their searching);
2. A lack of familiarity with more advanced sources, such as specialized texts in their field and academic, field specific journals;
3. A lack of familiarity with unconventional sources – both online and in print – such as design handbooks, government archives, standards and codes, manuals, etc.; and,
4. An inability to assess the credibility of sources found online and in print, and acknowledge that credibility in their use of the source.

One of the Praxis I instructors who also teaches multiple Capstone Design courses for senior students has encountered almost identical deficiencies in those students’ techniques for conducting scholarly research. The intent is that intervening in their Cornerstone Design experience will provide students with scaffolding that they can build upon, resulting in improved performance in their senior year.

Library Collaboration

In an attempt to overcome the aforementioned limitations of conventional approaches to teaching research skills, the Praxis instructors collaborated with the Engineering & Computer Science Library (ECSL) to develop a research-focused Studio and an associated set of activities. The goals of the Research Studio were to support the students’ bridge design assignment while simultaneously addressing the students’ research deficiencies. In keeping with the Studio approach to teaching, this required developing a series of activities that required active explorations on the part of the students.

The ECSL is part of the University of Toronto Libraries system, which consists of over 30 individual libraries spread across three campuses. The ECSL is a 1531 m² facility that holds approximately 200 000 items in 6536 linear meters of shelving, has study seating for 267 individuals, and has 36 computer workstations. Since the Research Studio was taking place in the ECSL in order to encourage students to interact with the physical information sources directly, the library itself was a limiting factor on the choice of research stations.

Although the ECSL is designed to be a collaborative workspace that allows and encourages group study, the addition of 100 students as part of an organized class posed some challenges. The activity did require heavy collaboration and physical movement of students at and between stations, so strategies were put in place to minimize the impact. To accommodate for the class in the limited space, stations were spread out throughout the library to minimize the impact on any one area. Signs were posted to notify library users well in advance that there would be a class using the library space. Areas, including tables and computer workstations that were required were also clearly marked to notify library users the date and times that the resources were required for the Research Studio. A notice on the ECSL’s web site and News Blog also went out to ensure library users were aware of the potential disruption.
The Research Studio

Though seemingly insignificant, the choice to identify the activity as a “research studio” was a significant one. Rather than refer to such activities as tutorials or workshops, small class activities in Praxis are labeled studios in order to better communicate their purpose and mode of operation. In the tradition of architecture studios, in which students work on their individual design projects while receiving targeted, individual feedback and instruction, students in Praxis Studios were encouraged to see the semi-structured activities as being immediately relevant to their individual projects. Students could, and were encouraged to, conduct research for their specific design projects concurrently, while completing the activities described below.

Specific stations within the Research Studio were chosen to (a) help the students complete their bridge design assignment, and (b) to introduce the students to relevant information sources that they may not be familiar with. The stations were designed to introduce students to many of the resources available at the University, as well as free sources available online.

The students were divided into teams of three to complete the Research Studio and also to complete the corresponding assignment. Each student went to three stations, so that at least one student in each team completed each of the six stations and two team members completed most stations. To help guide the students, at the start of the Studio they were each given an index card with an individual schedule of activities:

<table>
<thead>
<tr>
<th>Individual Designation: α</th>
<th>Individual Designation: β</th>
<th>Individual Designation: δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A – 14:30-15:00 – Station 2</td>
<td>Block A – 14:30-15:00 – Station 4</td>
<td>Block A – 14:30-15:00 – Station 6</td>
</tr>
<tr>
<td>Block B – 15:00-15:25 – Station 3</td>
<td>Block B – 15:00-15:25 – Station 5</td>
<td>Block B – 15:00-15:25 – Station 1</td>
</tr>
</tbody>
</table>

After 15:50 rejoin your group members, compare notes, and develop a plan for completing the Bridge Targeting Worksheet over the next few days.

You do not have to submit your bridges and criteria today.

Each student was also given a handout that outlined all six of the stations. The handout included the learning objectives for the Research Studio as a whole, as well as learning objectives for each station. The handout also outlined the specific activities to be completed at each station, and the station exit criteria. Students were given 20 minutes to complete each station, and 1:20 to complete the entire Studio. Teaching Assistants were present at each station to direct and support the students in their learning. Students worked in ad-hoc teams of two at all stations.

The stations that were developed for the Studio and used by the students were:

- “Station 1 – Journal Articles” where students explored journal articles in bound volumes
- “Station 2 – Evaluating Information” where students had to critically evaluate three web sites on a similar topic
- “Station 3 – City Sources of Information” where students looks at the City of Toronto Archives and the City of Toronto Projects Listings to identify potential bridges to evaluate as part of their bridge design assignment
- “Station 4 – Search Strategies” where students were required to construct search strategies with which to search for information related to their assignment;
• “Station 5 – Nontraditional Information Sources” where students explored the range of information sources available through the library
• “Station 6 – Books” where students explored different types of books and printed materials to discover the depth and breadth of information provided by different sources.

To better highlight some of the learning objectives and associated activities of the Research Studio, and their relation to the ACRL Information Literacy Competency Standards for Science and Engineering, four of the six stations are described in detail. The complete Studio handout, including the worksheets for each station, is included in Appendix B.

Station 1. Journal Articles

This station introduced students to journal articles, specifically those from *Structural Engineering International*. Issues of *Structural Engineering International*, a journal that primarily contains profiles of significant structures from around the world, were pre-selected for students to browse through. In pairs or small groups, students were instructed to select a profile of a bridge from the available issues and had to answer questions.

Selected learning objectives for this station, as stated in the handout, were to:

• Identify the metadata associated with journals and journal articles;
• Identify the key features of descriptive journals articles (minimally from *Structural Engineering International*); and,
• Extract information from a descriptive article (minimally from Structural Engineering International).

These learning objectives were designed to get students thinking about the metadata associated with articles (without having to cite the source using a specific citation method), and also to recognize the essential parts of the bridge profiles that they chose that they could use when constructing their bridge critique for their upcoming assignment. The handout also noted that the descriptive information and details that the students were extracting from the articles was also the same information that should be going into the students’ own bridge critique.

The learning objectives for this station can be mapped to the ACRL Information Literacy Standards for Science and Technology, specifically meeting Standard Two, Performance Indicator 5, Outcome (d), and working towards Standard 4, Performance Indicator 3, Outcome (a). The learning outcomes of this station also map to Standard Three, Performance Indicator 1, Outcome (b).

Additional peer-reviewed journals were also on hand so the students could compare the descriptive journals articles from *Structural Engineering International* to a peer-reviewed article, and introduce the peer-review process. This helps students to work towards Standard 1, Performance Indicator 1, Outcome (a). A complete explanation of the ACRL Standards, Performance Indicators and Outcomes that are associated with this station are included in Appendix A.
This station proved to be a challenge to some students in ways that the teaching assistants, faculty members and librarian did not anticipate. While the majority of students were able to discern the metadata from the bridge profile that they chose, there were students who required assistance in locating the volume or issue information of a particular article. However, students were able to discern important characteristics of the “bridge description” genre, an otherwise highly specialized and challenging (at least for freshmen) type of document that they would need to write for two of their courses this term. Reading the bridge design descriptions also helped them to flesh out components and aspects of bridges to explore in their own designs, and provided a first glimpse into reference structures that were needed to back up their design claims.

Station 2. Evaluating Information

This station required students to critically evaluate three online sources, all related to the Confederation Bridge, which joins Prince Edward Island to mainland Canada. This example was chosen because it is a well-known Canadian bridge that would not be used by students for this assignment.

Students were asked to answer preparation questions regarding their current use and critique of information resources before evaluating the sources themselves. The sources chosen were the official website of the Confederation Bridge (http://confederationbridge.com/en)², a Wikipedia article on the Confederation Bridge (http://en.wikipedia.org/wiki/Confederation_Bridge)³ and a personal website for the Confederation Bridge (http://www.tourcanada.com/cbridge.htm)⁴. Students were asked to assess the accuracy, authority, bias, audience level, and currency of each of the web sites. Students were then asked reflection questions, to help them transfer the critical thinking skills used in this exercise to their assignments and everyday life.

Selected learning objectives for this station, as stated in the handout, were to:

- Reflect on the quality of habitually used online resources;
- Use the criteria of accuracy, authority, bias, audience, and currency to critique a variety of related web sites; and,
- Reflect upon the appropriateness of a variety of websites for use in University level assignments and investigations.

These learning objectives reflect ACRL Information Literacy Standards for Science and Technology¹ Standard Three, particularly Performance Indicator 2. Outcome (b) and Outcome (c) are both applicable.

This station was designed to challenge students’ current ideas of what appropriate sources of information are when completing undergraduate engineering projects at the University. In the context of the course this is an essential research activity: students are required to select credible sources to back up their designs in all of their work. Where many instructors forbid the use of Wikipedia, Praxis I encourage students to assess the credibility of any given page, acknowledging Wikipedia’s process (for example, that pages on sensitive political topics may be more biased and problematic than technical topics.) We specifically directed students to explore
the “View History” and “Discussion” links on Wikipedia pages to help them assess the credibility of that page, and we did encourage finding corroborating sources when using Wikipedia. Surprisingly, the vast majority of the students were unaware that every Wikipedia page has an associated “Discussion” page.

Even though students were given the criteria for evaluating the websites, the application of the criteria varied among some of the students. Some students had difficulties assessing the authority of the website, even with guidance in the handout. In a conversation with students regarding the aesthetics of a website, students argued that a well-designed website would be more credible than one that looked out of date or had poor aesthetics. On the other end of the spectrum, a student well versed in Wikipedia conducted an experiment that involved editing the page and adding erroneous information to see how long it would take to correct. Their edit was reverted within four minutes.

Station 4. Search Strategies

The Search Strategies station required students to create a search strategy that students could use to identify specific bridges, to find information on the bridge and criteria with which to assess the bridge. Students were instructed to brainstorm words or phrases that could be used to find the information required, and then had to construct two separate search strategies: a search strategy that could be used in a popular media search (e.g., Canadian Newsstand) and a search strategy that could be used for a scholarly search (e.g., Scholars Portal). Examples of search terms and Boolean operators on an engineering topic not related to their current project were given to students in order to demonstrate the concepts.

Selected learning objectives for this station, as stated in the handout, were to:

- Be forced to develop a search strategy before actually trying the searches;
- Consider the importance of vocabulary, synonyms, and etymology when developing search strategies;
- Incorporate truncation and Boolean operators into a search strategy; and,
- Develop and explore the differences between a search strategy targeting scholarly works and one targeting works from popular media.

The learning outcomes for this station represent ACRL Standard Two, Performance Indicator 2, Outcome (b). Outcome (d) is also applicable.

Students had difficulties grasping the concept of this station. Planning a search was not a concept that was comfortable for the students; they wanted to go right into searching, and the forced disconnect between the two activities appeared to confuse the students. To help students understand the importance of vocabulary and search strategies, an additional handout that included keywords used to describe an article, screen shots of the Google advanced search page, the Scholars Portal database search page, and the Archives Canada Search page. In addition, various resources were included at the station, such as general and engineering specific dictionaries and thesauri, to assist students in brainstorming keywords that could be used in their
search strategies. Students were encouraged to use the thesauri and dictionaries to generate lists of broader, narrower and similar terms that could be used in the search strategy.

One example that highlighted the importance of terminology in keyword searching that seemed to resonate with the students occurred when students were given three different bridge names to and asked to differentiate between them; all three names are used for a bridge located in Toronto. If students had used just one or even two of the names to search for information on that bridge, they still might have missed relevant information on that bridge. That seemed to motivate students to formulate more complex search strategies and look more closely at the terms that they used.

In the future if this exercise were to be run again, a database search station would follow this station, where students could try their searches in scholarly and media databases. This would improve the students’ experience with developing search strategies, and would also allow them to modify their search strategy based on their search results, developing additional information literacy skills in the process.

Station 5. Nontraditional Information Sources

In this station, students were asked to quickly explore the range of information sources provided by the library, focusing on so-called “non-traditional sources.” This forced students to acknowledge their assumptions and preconceptions of “library” research, and push beyond them. Students were asked to partner and take ten minutes to wander the ECSL identifying and recording different sources of information that they might not have considered previously. Instructors suggested beginning with a map and using library signage to explore all of the resources offered by the library, but did also steer student groups in the right direction when necessary towards sources such as provincial and national codes for buildings, structures, etc., design handbooks, and standards manuals. After their initial exploration, groups of students were asked to share their results with others, and discuss within a group of students how the non-traditional sources they found could be relevant to engineering design.

Selected learning objectives for this station, as stated in the handout, were to:

- Quickly explore the range of information sources provided by the Library;
- Identify new information sources that you might not previously have considered or been aware were available; and,
- Continue to push yourself to seek additional information sources beyond those which you are familiar with.

These learning objectives map to the ACRL Standards\(^1\), including Standard 1, Performance Indicator 2, particularly Outcomes (a), (b), and (c), as well as Performance Indicator 3, particularly Outcome (d).

At this station, most students were able to discover important resources they would have otherwise overlooked. More importantly, the exercise was able to elicit key assumptions they held about what constituted credible sources for their engineering design work, and broaden their
understanding of engineering research. In particular, students realized that they had limited themselves to searching for journal articles, conventional books, textbooks, and had not considered sources such as handbooks (in particular design handbooks), manuals, and standards and codes. Given the nature of their project, these sources were highly relevant and helped students to recognize the importance of broadening their research horizons.

One of the more important discoveries facilitated by the station was the acknowledgement of “people” as an essential “non-traditional” source of information, a finding repeated over and over as groups went through the station. In discussions led by instructors, students acknowledged that they were very much aware of librarians and their role, but had often avoided directly asking them for research help. Those students who had approached librarians before usually approached with a very specific question, such as the location of specific journals and books already uncovered through catalogue or Internet searching. In this station, they were also encouraged to ask for more general research help, such as how to find information on bridge reference designs, the different types of resources available, and even where to look for answers to specific bridge related questions.

Students generally met the intended objectives of this station, and found the “non-traditional sources” we expected them to find. However, they pushed beyond our preconceptions of what constitutes “non-traditional sources.” In the future, the station will specifically address the role of librarians and other experts as sources of a wider range of information than perhaps expected.

Results

While still awaiting analysis of the final results of the Faculty’s standard, anonymous course evaluation survey, informal feedback provided through journal entries on the Research Studio has garnered mixed results. On a very basic level, the physical introduction to the library seemed to work, as indicated in this post to the online journal system associated with the course:

“At the start of our bridge themed projects (both for CIV102 and ESC101), we were introduced in Studio 4 the wonder that is the Sanford Fleming Library. Never before have I heard of such a place, as it definitely isn’t in the most conspicuous location; I wouldn’t be surprised if half the engineering student population didn’t know about the library.”

Most of the positive feedback has come from the assessment team in Praxis I, who have seen a significant change in the student’s attitudes to research, and understanding of research as an activity, when compared to the students in previous iterations of the course. Anecdotally, a larger number of students have been citing specialized books and journal articles, rather than relying on simple web resources for their documents, and evidence from the online journals also indicates an acknowledgement of their preconceptions about research processes:

“Back when we did the Library session where they taught us how to research properly and find credible and useful information. Researching has always been an area I could improve upon, I’ve never been particularly efficient at it.”
Student reflections have also contradicted our own assessments of some of the activities described above. This one, for example, argues that, despite initial reactions, the search strategy studio was useful:

“Some of my reflections on this studio were that for the search strategies activity we needed to have access to a computer to compare the results we got using different terms. To get a better feel of what is a good search strategy. However I do now think about the terms I use while searching whereas before I never did so it had to have been partly effective at least to make me aware of the fact that different terms can lead to better searches.”

The critical responses have been useful in shaping our own views on the activity. For example, the following student response has helped us to understand some of the limitations of the studio:

“I personally found that the library visit was too structured. We were sent off to explore the library in workstations and given worksheets which to be honest were more troublesome then anything else. I don’t feel that it was effective at showing students the large amount of resources the library has to offer. I base this on the fact that I learned substantially less during this visit then I did during my own personal visits before and after. I feel that rather then having students venture off alone with worksheets which were more distracting then helpful, perhaps have a librarian speak to them about the different resources available during the first half hour, then let students check out the resources that interest them most during the last part of studio.

My justification for why this may be more effective is because during my own visit a week later when I visited a librarian showed me the different resources available. Such as the various journal sites such as COMPENDEX as well as the codes resource which has online copies of various Canadian codes such as the Ontario highway bridge design code and the Canadian building code. I personally have found these resources very helpful and believe my peers will as well. I strongly suggest that you attempt this approach (and perhaps modify it slightly to make sure the students stay on task, so perhaps a work sheet may be beneficial after all), as I feel students can’t afford to not know about these various resources.”

This student response speaks to frustrations of other students who were not able to complete all of the six stations: while we ensured that each group of students covered all stations, we were unable to guarantee that every student would do so. The resources that the student mentions above were all covered in the Studio, but not in the stations she attended. Perhaps, as one student put it, we are putting “too much faith into [their] intragroup communication. I don’t feel as though a ‘sense of shared responsibility and ownership’ was fostered by this activity and I don’t think that it’s realistic to expect that the group gives each member full access to a shared knowledge base, at least, to any degree that would be useful. (In other words, I definitely feel as though I’m missing out on some valuable information.)”

Conclusions
While not without its limitations, the Research Studio proved to be a valuable addition to the course, with the collaboration between librarians and faculty providing students with a set of activities designed to break preconceptions about the nature and credibility of different types of
research sources. At the very least, students were exposed to the physical library, a range of sources, and new genres of writing that were relevant to their current projects. Perhaps the best testament to its success is that in a subsequent Praxis I project, two student groups proposed as their topic developing improvements to the the ECSL activity for the next iteration of the course.

References


Appendix A: ACRL Standards for Science and Technology by Research Studio Station

Station 1 – Journal Articles

• Standard Two: The information literate student acquires needed information effectively and efficiently.

  ➢ Performance Indicator 5: The information literate student: Extracts, records, transfers, and manages the information and its sources. Outcomes include that the student:

    (d) Records pertinent information for future reference by downloading, printing, emailing, or manual notation

• Standard Four: The information literate student understands the economic, ethical, legal, and social issues surrounding the use of information and its technologies and either as an individual or as a member of a group, uses information effectively, ethically, and legally to accomplish a specific purpose.

  ➢ Performance Indicator 3: The information literate student: Acknowledges the use of information sources in communicating the product or performance. Outcomes include that the student:

    (a) Selects an appropriate documentation style for each research project and uses it consistently to cite sources
• Standard Three: The information literate student critically evaluates the procured information and its sources, and as a result, decides whether or not to modify the initial query and/or seek additional sources and whether to develop a new research process.

  ➢ Performance Indicator 1: The information literate student: Summarizes the main ideas to be extracted from the information gathered. Outcomes include that the student:

    (b) Selects main ideas from the texts

• Standard One: The information literate student determines the nature and extent of the information needed.

  ➢ Performance Indicator 3: The information literate student: Has a working knowledge of the literature of the field and how it is produced. Outcomes include that the student:

    (a) Knows how scientific, technical and related information is formally and informally produced, organized, and disseminated

Station 2 – Evaluating Information

• Standard Three: The information literate student critically evaluates the procured information and its sources, and as a result, decides whether or not to modify the initial query and/or seek additional sources and whether to develop a new research process.

  ➢ Performance Indicator 2: The Information Literate student: selects information by articulating and applying criteria for evaluating both the information and its sources. Outcomes include that the student:

    (b) Distinguishes among facts, point of view, and opinion

    (c) Examines and compares information from various sources in order to evaluate reliability, validity, accuracy, authority, timeliness and point of view or bias

Station 4 – Search Strategies

• Standard Two: The information literate student acquires needed information effectively and efficiently.

  ➢ Performance indicator 2: The information literate student constructs and implements effectively designed search strategies. Outcomes include that the student:

    (b) Identifies keywords, synonyms and related terms for the information needed and selects an appropriate controlled vocabulary specific to the discipline or information retrieval system
(d) Constructs a search strategy using appropriate commands for the information retrieval system selected (e.g., Boolean operators, truncation, and proximity for search engines; internal organizers such as indexes for books)

Station 5 – Nontraditional Sources of Information

• Standard One: The information literate student determines the nature and extent of the information needed.

➢ Performance Indicator 2: Identifies a variety of types and formats of potential sources for information. Outcomes include that the student:

(a) Identifies the purpose and audience of potential resources (e.g. popular vs. scholarly, current vs. historical, external vs. internal, primary vs. secondary vs. tertiary).

(b) Considers experts or other researchers as potential information resources.

(c) Identifies the value and differences of potential resources in a variety of formats (e.g., multimedia, database, website, data set, patent, Geographic Information Systems, 3-D technology, open file report, audio/visual, book, graph, map).

➢ Performance Indicator Three: Has a working knowledge of the literature of the field and how it is produced. Outcomes include that the student:

(d) Is knowledgeable of sources that are specific to the field, e.g. manuals, handbooks, patents, standards, material/equipment specifications, current rules and regulations, reference material routinely used in industry, manuals of industrial processes and practices, and product literature.

Appendix B: Worksheets for Stations in the Research Studio
Learning Objectives
- Begin the process of moving from a naïve to a sophisticated approach to research.
- Find a partner among the students currently assigned to this station.
- Collectively complete the remaining three (3) Stations in your own time.
- Begin to identify the criteria that you will use when you visit and critique a bridge.
- Apply the skills of critique learned in Studios 02 and 03 to sources of information.
- Utilize the six Stations to begin exploring some of the skills required to do effective research in both traditional and non-traditional domains.
- Establish your own research questions.

Exit Criteria
- You have completed the six Stations and are ready to begin your bridge visit.
- You have identified at least three (3) bridges, based on the work done at the Stations, that you are interested in visiting over the next two (2) weeks.
- You have begun to profile the bridge you will be visiting for your next assignment.
- You have extracted information from a descriptive article contained in the Journal of Bridge Engineering.
- You have learned how to perform searches for books, academic articles in journals, and other authoritative published sources.
- You have begun to identify the metadata associated with journals and journal articles.
- You have begun to apply the skills of critique learned in Studios 02 and 03 to sources of information.

Activities
- Browsing through the articles in a specific journal or journals is one way of finding useful or relevant articles.
- A more time-efficient way of searching for articles is to use a database.
- The term "research" can involve a large range of activities, ranging from searching for information on an online search engine to interviewing experts or subjects in the field.
- Traditional research skills include skills related to performing searches for books, academic articles in journals, and other authoritative published sources.
- Non-traditional research skills include skills related to interviewing experts or subjects in the field.

Books
- Structural Engineering International
- Journal of Bridge Engineering
- The Journal of Bridge Engineering
- Building good research skills is especially important for students in Engineering Science.

Structural Engineering International
- The Journal of Bridge Engineering
- The Journal of Construction Engineering & Management
- Construction Innovation
- The AASHTO Journal
- Civil Engineering

Journals
- The Journal of Bridge Engineering
- Building good research skills is especially important for students in Engineering Science.

Metadata Questions
- What is an appropriate bibliographic citation for the article?
- When was the article submitted?
- Who are the author(s) of the article?
- What is the title of the article?
- What volume and issue did the article appear in?
- Did you find the article in a database?
- Is the article from a proceedings, and can you ask the Librarians for assistance?
- What does the article contain?
- Where does the article come from?
- What is the article about?
- What is the significance of the article?
- What is the purpose of the article?
- What is the main idea of the article?
- What is the thesis of the article?
- What is the conclusion of the article?
Station 2 – Evaluating Information

Learning Objectives
• Reflect upon the quality of habitually used online resources.
• Use the criteria of accuracy, authority, bias, audience, and currency to critique a variety of related websites.
• Reflect upon the appropriateness of a variety of websites for use in University-level assignments and investigations.

Background
All information sources are not equal. Just because you can easily find a piece of information does not mean that it is accurate or appropriate to use in course work. You should evaluate information and only use the best sources. Remember, as an engineer, you may be responsible for designing things for use by others; you want to make sure that the information that you are basing your designs on is the best information available, not just what was easy to find.

At this station, you will use the Library computers to critique three different web sites that present information related to the Confederation Bridge.

Activities
1. Find a partner among the students currently assigned to this station.
2. Working with your partner, complete the Preparation Questions given on this page.
3. Complete the Website Critique on the subsequent pages for this Station.
4. Complete the Reflection Questions for this Station.

Preparation Questions
If you were looking for information on a particular bridge, what online resources would you use to find the information?

How useful is the information you usually find when you use these resources?

How reliable is the information you usually find using these resources?

Website Critique
Confederation Bridge:

Wikipedia:
http://en.wikipedia.org/wiki/Confederation_Bridge

PEI's Confederation Bridge:
http://www.tourcanada.com/cbridge.htm

Criterion 1 – Accuracy
(e.g., Is the information factual? Is it free of errors or omissions?)

Website
Confederation Bridge
Wikipedia
PEI's Confederation Bridge

Criterion 2 – Authority
(e.g., Who created the website? What are his/her credentials? Is the author qualified to provide information on this topic? Are additional sources referenced?)

Website
Confederation Bridge
Wikipedia
PEI's Confederation Bridge

Criterion 3 – Bias
(e.g., is the information an opinion? Is it logical and well reasoned? Is it free from emotion or bias?)

Website
Confederation Bridge
Wikipedia
PEI's Confederation Bridge
Criterion 4 – Audience Level
(e.g., is it aimed at professionals, the general public, pre-school children?)

Reflection Questions
Would you use any of these resources in your day-to-day life (for example, if you were going to visit the Confederation Bridge)? Which ones? Why or why not?

Would you use any of these resources in a university-level project? Which ones? Why or why not?

Which aspects of the evaluation (accuracy, authority, bias, audience level, currency) most influenced your decision on whether or not you would use the information in your day-to-day life or in your school projects?

If you wanted to use the best information available to make a decision related to visiting the Confederation Bridge, which one of these three web sites would you base your decision on? Why?
Station 3 – City Sources of Information

Learning Objectives

• Become familiar with some of the curated and non-curated information sources provided by the City of Toronto.

• Use the City of Toronto Archives online interface to identify a potential bridge to visit.

• Use the City of Toronto Projects listing to identify additional factors to consider when exploring or critiquing a bridge.

1. Activities

Using Google is a great way to find information quickly, but did you know that it isn't always (or even often) the best way of finding information? There are other resources provided by the City of Toronto that you might consider when you are looking for information on different bridges. In the case of an odd number of students, one student may partner with a Teaching Team member or Librarian. Find a partner among the students currently assigned to this station.

This web site lists current projects that are currently underway in Toronto. There is also a link on the page to find an online archive of projects that have been completed.

http://www.toronto.ca/involved/projects.htm

2. Question

Using this information, what is your plan for your project? What kind of information is included in this information on GTA bridges?

3. Archive Entry Questions

What is the archival citation for this entry?

What is the procedure?

Can you request or view these items?

What are the copyright conditions for these items?

What are the access conditions for these items?

Which bridge does this entry have information on?

What is the start date and end date (or projected end date) of the work?

What is the name of the designer/architect?

What is the status of the project?

4. Learning Objectives

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Station 4 – Search Strategies

Learning Objectives
• Be forced to develop a search strategy before actually trying the searches.
• Consider the importance of vocabulary, synonyms, and etymology when developing search strategies.
• Incorporate truncation and Boolean operators into a search strategy.
• Develop and explore the differences between a search strategy targeting scholarly works and one targeting works from popular media.

Background
You need to find resources on bridges in Toronto. When searching for material, it is often a good idea to think a lot about your search before you actually do it.

One approach is to decompose your search into different components, and then try to think of other terms for those components. For example a search for materials on "the sustainable design of residential buildings" might decompose into the core concepts of:

• Design for sustainability
• Residential buildings

Starting from these core concepts, other broader, narrower, related, or similar terms might include:

• Sustainable design
• Green building
• Sustainable engineering
• Green design
• Residences
• Multi-dweller residences
• Apartment building
• Apartment buildings
• House
• Houses
• Housing
• Homes

Since you might be looking for the singular or plural form of a word, or some words might have multiple spellings (e.g., labor vs labour) many databases use truncation. Truncation (often indicated by appending an * after the search term) means that you can search for "engineer*" and receive results containing "engineer", "engineers", "engineering", etc.

Most search tools also support Boolean Operators that allow you to combine your search terms in various ways. For example:

At this station you will begin to craft a search strategy that you can use to identify specific bridges that you may wish to visit, and criteria you can use to assess those bridges.

Activities
1. Find a partner among the students currently assigned to this station.
   In the case of an odd number of students, one student may partner with a Teaching Team member or Librarian.
2. Working with your partner, develop a search strategy that focuses on finding scholarly or research works relating to your bridge and criteria.
3. Working with your partner, develop a search strategy that focuses on finding popular media reports (e.g. newspaper articles, television programs) relating to your bridge and criteria.

Scholarly Search Strategy

Popular Media Search Strategy

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Station 5 – Nontraditional Information Sources

Learning Objectives

• Quickly explore the range of information sources provided by the Library.
• Identify new information sources that you might not previously have considered or been aware were available.
• Continue to push yourself to seek additional information sources beyond those which you are familiar with.

Background

Different sources have different types of information. You wouldn’t look for the most recent research in biomedical engineering in a textbook for a high school biology course. The subject matter, the intended audience of the material, and the type of information are all important factors when you are looking for information.

At this station you will identify and characterize new information sources provided by the Library that you may not have been previously familiar with.

Activities

1. Find a partner among the students currently assigned to this station.
   In the case of an odd number of students, one student may partner with a Teaching Team member or Librarian.

2. Take 10 minutes to wander the Library identifying and recording in the areas that follow, different sources of information that you might not have considered previously. This may involve looking at a map of the Library, looking at the signs on the end of the shelves or attached to the ceiling, etc. Return to this Station when you are done.

3. Compare notes with at least two other teams to develop as complete a list of nontraditional (for you) sources of information that you can use to identify bridges to visit and criteria to use when critiquing a bridge.

<table>
<thead>
<tr>
<th>Source</th>
<th>Level of detail provided</th>
<th>Kind of information provided (e.g. historical, research, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC101</td>
<td>Level 1</td>
<td>Library Orientation Workbooks – REV. 1.0</td>
</tr>
</tbody>
</table>

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Learning Objectives
• Experience quickly assimilating the contents of a book
• Explore different types of books and assess their suitability for different purposes.
• Explore the physical organization and arrangement of books covering related topics.

Background
As you are already aware, Engineering & Computer Science Library contains many books (over 100,000 of them). 10 of these books have been pre-selected as being potentially relevant for your upcoming bridge design project.

At this station you will scan and characterize a variety of different types of books and will explore the physical organization of the books in the Library Stacks.

Activities
1. Find a partner among the students currently assigned to this station.
   In the case of an odd number of students, one student may partner with a Teaching Team member or Librarian.

2. Working in pairs, examine at least 3 of the 10 pre-selected books. In the areas provided note anything you think might be significant about each of the books you examine.

3. Answer the "Book Questions" given on the subsequent pages for this Station.

4. All of the pre-selected books all come from the TG section of the library. Go to the book stacks and explore the TG section.

5. Answer the "Stacks Questions" given on the subsequent pages for this Station.

Book Questions
What are two things that all of the books have in common?
What kinds of information do the books contain? (e.g., research, historical, etc.)
There are at least three different types of books on the tables. Name the types, and why you might want to look in each type of book.
How detailed is the information in each resource? Is it on one specific topic, or does it cover a variety of topics?
If you were looking for introductory material on bridges, which book would be the best to look at? Why?

Stacks Questions
What do these books have in common?
Do you see any patterns in how the books are arranged?