Lifelong Learning in an Engineering Communication Course

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S. Norma Godavari, MLIS, has been the Engineering Librarian at the University of Manitoba, well, since a goodly number of years now (+30) and never fails to be amazed at the creativity and imagination of our engineering students. We continue to learn from each other all through their formal education and even beyond sometimes. She has become involved as the liaison librarian in the Engineering Faculty, especially in the Engineering Communication course, teaching and assisting in the evolution of the course, as well as with Mechanical and Civil capstone and thesis courses. Norma is on a research leave this year.

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1.0 Introduction and Objectives

The Canadian Engineering Accreditation Board (CEAB) has defined lifelong learning as a student's "ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge" [1]. ABET, through the Washington Accord, sets the standards for programs around the world including Canada to ensure a "global quality assurance process for STEM education programs through numerous agreements with organizations worldwide" [2] . Of course, this includes ABET Criterion 3i: Student Outcomes; "a recognition of the need for, and an ability to engage in life-long learning", which, in Canada, becomes Graduate Attribute, Criterion 12, Lifelong Learning. The ABET Student Outcomes a-k reflect essentially the 12 CEAB Graduate Outcomes 1-12.

The purpose of this paper is to present one way that we use to assess how our students address their information needs for an assignment: a Report for our Engineering Communication course. The assessment form, the Search Strategy Page (see Appendix A), is given to all students in the undergraduate Engineering Communication course and the results are factored into the professor's grades and evaluation of each student's work for both a team-based Proposal and a Final Report.

Aspects of the report's assessment reveal how students have understood their information literacy lectures and their use of that knowledge in searching for pertinent information and data in writing their Proposal and, ultimately, for their Final Report. Of course, students can address queries to the Librarian at any time, but each student must submit their own Search Strategy Page for at least their Proposals. The Search Strategy Page reveals both how students think about their searching as well as their assessing of the materials selected in writing their Proposal and Final Report. This reflects their future competence in keeping current and assessing engineering information, factors in their lifelong learning abilities. As Cicek has stated in her study of the essential role of lifelong learning, "having students reflect on their educational experiences enabled them to exhibit their appreciation of lifelong learning as a necessary and valuable skill and behaviour [3].

The Search Pages also afford the Librarian an opportunity to interact with each student as they refine their research as needed in written replies or arranging consultations; it also gives the Librarian a reflection on her teaching and subject analysis techniques for future classes.

2.0 The Engineering Communication Class: The Context

In each Engineering Communication class, we teach approximately 60 students, ranging in age from 18-22. This is a team-based course that challenges students to research, write and illustrate a significant research project on an engineering topic. As members of a team, students must learn the critical skills of project management, conflict resolution and effective group interactions – all part of developing the communication and professionalism skills expected of our students.

The present day access to data and information is a challenge; it is not simply Googling for information. Hence, university students need to learn information literacy techniques, especially in a complex arena such as the engineering fields to ensure they access credible, reliable sources of timely information. At the same time that we instil good communication practices, however, we have also integrated information literacy into the course as a way to develop the skills needed for lifelong learning to begin and continue; specifically, by having the engineering librarian offer four lectures on researching a topic, avoiding plagiarism, citing sources and navigating the databases, skills that will be useful as students enter their senior classes and eventually the profession.

The librarian also assesses their search strategies and bibliographies, and evaluates the quality of the sources. The communications professor meanwhile evaluates the quality of the content and the writing of the report itself as well as the annotations. Given that the half-life of engineering information and, by extension, an engineer's degree, is between 2-7 years [4], students, even before they graduate, need to develop the drive to keep learning. Because the professional engineering organizations make communication and lifelong learning opportunities a strong part of their mandate, we try to awaken the students' desire to keep on learning by promoting the critical importance of lifelong learning in their professional lives; by introducing them to practicing engineers who highlight the importance of communication and lifelong learning in the workplace; and by instantiating reflective learning into the course.

For example, we incorporate personal reflections into some of the assignments and group activities. The goal is to encourage students to step back, as it were, and reflect on things that went well and things that didn't go so well; we also encourage them to consider ways to avoid such pitfalls in the future and build on what they've learned. For example, the portfolio assignment asks students (as part of the assignment) to provide thoughtful responses to what each of them has learned about their strengths and weaknesses as a writer (such as their use of language, organizing their writing effectively, and developing clarity in their writing), and what areas each of them will continue to work on as they move forward. We also ask them to consider the value of the two peer reviews we have conducted during two writing labs, where students both give and receive oral and written feedback on each other's writing.

Additionally, one group activity that has proven to be useful, not just to the overall well-being of the team, but also to their awareness of lifelong learning, is a verbal update given by each individual on a team. This update includes a statement of their progress on their work as a member of the team; that is, what they have done so far, what remains to be done and how they would evaluate their progress so far. As a team member who also has the responsibility of overseeing the various tasks to be done, students also provide any strategies they have in mind to keep the work going or to get back on track. Individual progress, as one measure of team performance, forces student team members to take stock of their productivity. As well, providing strategies to their colleagues helps them to figure out ways to help everyone actually do the work. A final requirement is suggesting any changes the team should consider so that the work does indeed go more smoothly.

Interestingly, between 2013-2018, we surveyed approximately 450 students in the Engineering Communication class [5] and asked them a series of 20 questions related to 4 key areas: written communication, oral communication, teamwork and lifelong learning. We surveyed the class twice, once at the beginning and once at the end of the term to see if there were any changes in their self-reported levels of confidence and proficiency. As well, in the second survey (see Appendix B), we asked them to also rate where they think they will have to be when they graduate. Both surveys asked them to rate (on a scale from 1-5) their current or expected future confidence and proficiency, defined here as students' being able to identify their own educational needs and also being able to develop ways to maintain their competence in the discipline [3].

For lifelong learning, specifically, we asked students to identify personal areas of strengths and weaknesses; different ways to develop the strengths and eliminate the weaknesses; ways to develop broader knowledge; and ways to apply critical inquiry and analysis to engineering problems and to the communications that support the engineering work. On "working to develop broader knowledge," students were quite confident (3.64 out of 5) and only marginally lower when it came to identifying their personal strengths and weaknesses (3.54 out of 5). However, they were far less confident in identifying ways to develop or eliminate these traits (3.23 out of 5) and to applying analysis to engineering problems and the subsequent communications (3.22 out of 5).

So, one conclusion might be that students still have much to do when it comes to lifelong learning, but these assignments and activities do help to propel them into considering lifelong learning as a vital component of their academic program. We subsequently built on these results to introduce activities such as personal reflection and group learning into the engineering communication classroom. For example, we have two student teams work together on their projects so they can learn more about technology, on the one hand, and writing, on the other. In this way, we likewise encourage these students to continue to keep learning over their 30-year-long professional career.

3.0 Lifelong Learning Background

The goals of the information literacy components of the communication course are similar to those of Feldmann and Feldmann's [6] assignment for their class, which are the following: to make students aware of the rich store of information available; to help the students learn the basic skills needed to locate their needed information; to encourage team-based interaction on their project; to understand the ethics of publishing; and to allow students to delve more deeply into a subject. The Search Strategy Page, as mentioned earlier, is a vehicle to study and report on students' progress.

In this undergraduate engineering class, we teach for that class but keep in mind the need to encourage students to keep learning, keep searching and keep refining their ability for writing/communicating well, over their coming 30-year-long professional career. The lifelong learning standard was established in the 2000 ABET accreditation process with criteria 3i that stated that programs must demonstrate that their students attain "a recognition of the need for, and an ability to engage in lifelong learning" [7]. Canada followed with 3.1.12, Lifelong Learning [1].

Since standards are the language of engineering, their education needs to "ensure the highest standards of engineering education, professional qualifications and professional practice" [1]. This ensures that graduates from any engineering school are able to work as professional engineers even in any country, especially now when borders and jobs are more fluid and international. The Association of College and Research Libraries (ACRL) has Information Literacy Standards for Science and Engineering/Technology which parallel and enhance the standards for the ABET and CEAB graduate attributes for engineering programs [in Criterion 3 and Graduate Attributes 3.1, respectively]. The five ACRL standards and 25 performance indicators evaluate information literacy skills in the science and engineering area specifically:

> Information literacy competency is highly important for students in science and engineering/technology disciplines who must access a wide variety of information sources and formats that carry the body of knowledge in their fields. These disciplines are rapidly changing and it is vital to the practicing scientist and engineer that they know how to keep up with new developments and new sources of experimental/research data. [8]

Not only do engineers need to measure up to accreditation standards, but also they should be aware of the necessity of keeping up to date. The half-life of engineering information is only 2-7 years [4] and Smerdon [9] has stated that a "group of experts estimated the half-life of an engineer's technical skills--how long it would take for half of everything an engineer knew about his or her field to become obsolete. For mechanical engineers it was 7.5 years. For electrical engineers it was 5. And for software engineers, it was a mere 2.5 years, less time than it takes to get an undergraduate degree. Today, those numbers are surely even smaller." In addition, Asokan [10] stated that scientific and technical knowledge doubles approximately every 10 years. "Futurist and inventor R. Buckminster Fuller [11] estimated that up until 1900 human knowledge doubled approximately every century. By 1945 it was doubling every 25 years, and by 1982 it was doubling every 12-13 months. IBM estimates that in 2020 human knowledge will be doubling every 12 hours" [12]. As a result, as older technologies become obsolete, engineers must stay current to keep them and their companies up to date and know what is passe. Current and future technologies' development keep companies profitable and ensures the employability of those engineers who enhance their company's bottom line.

Graduates should be ready to hit the ground ready to learn new techniques, tests and procedures; that is, be open to new ideas. Not being aware of them can affect a grad's successful job searching and retention as many engineering companies require "an intense technical test before [the grads] receiv[e] an offer" [13]. Jobs are no longer that permanent as well. Naimpally, Ramachandran, and Smith [14] noted that "there are relatively few lifetime jobs left in engineering, and new engineers do not even expect they will stay with one company for 25-30 years." Often engineers work for special projects all over the world as their career.

In Canada, lifelong learning is now an integral part of an engineer's professional licensing. In Manitoba, for example, Engineers Geoscientists Manitoba [15] has added the ProDev Program, which is "consistent with the national guidelines for continuing professional development and continuing competence recommended by Engineers Canada." The ProDev Program has six categories in which to report credit hours activity: Professional practice, Formal activities (courses), Informal activities (self-directed studies, conferences, seminars), Participation (service, mentoring, community work), Presentations (conferences, companies), and contribution to knowledge (publications, patents, thesis, editing). Reports are to be filed from at least three of the six categories every year. Cheville, Madhavan, Heywood and Richey [16] see a possible challenge in having a fragmented educational system (industries, associations, etc.). They point out that "industry invests in courses and credentials because learning has a direct effect on business." They may see a future in new forms of industry–university partnerships that "may lead to a life-long relationship between students and the university as insurance-based models allow for regular updates to their education."

It is vital that undergraduate engineering students learn about the tools of information literacy as well as consider how useful they are for finding their authoritative sources of information while at a university. However, most of these tools may not be readily available once they are practicing engineers. University library access is often terminated after graduation and many engineering companies do not have libraries. Other libraries such as the public library may play a continuing education role. IFLA [17] has pointed out in the *Role of Libraries in Lifelong Learning* that "[t]he aim of the proposed project is therefore to explore the possibilities for public libraries to play a more strategic role in lifelong learning [and to] establish tools for libraries and librarians to become active partners in educational systems."

4.0 Information Literacy within the Engineering Communication Course

The Search Strategy Page [Appendix A] assesses the students' lifelong learning potential where each student fills it out and submits it twice a term, once with their proposal and then an updated Search Strategy Page when they submit their final report. This form contains several key questions that each student fills out about their topic, their specific focus, how and where they have searched, and how they value each search tool for discovering their authentic engineering information. Each Search Strategy Page also provides a direct means of communicating with each student on their searching and on their information needs. The assessment of the forms is factored into the class rubric on a team basis.

Information literacy is an integral part of engineering education, providing objectivity, critical thinking, problem solving and subject analysis in searching for answers to design questions. Rodrigues [18] noted that, in effect, engineers with solid research skills will generally produce more thorough reports than those without and that engineers that use information well, not only have a competitive advantage over those that don't, they avoid the cost of being misinformed which can be devastating.

Our four information literacy classes cover the following areas: 1. General research needs and class expectations; 2. Search engines (Google and Google Scholar); 3. Databases searching (Primo, EiVillage and IEEE Xplore and Document Delivery); 4. "Law and Order" (Copyright and Plagiarism). Each of these resources is considered a vital engineering tool that students need to know how to use effectively. For example, everyone thinks that they are masters at searching Google since they often retrieve millions of records for their terms, even if they are misspelled. The Googles are a vast tool to master and offer a rich subset of tools as well. The Databases class, the third class, introduces students to using Primo, the Engineering Village and to IEEE Xplore, pointing out the similarities and differences between a search engine and a database and efficiently using them.

The first three classes, given before their Team Proposals are due (approximately one-third of the way through the course), establish a foundation for their research. Each student submits a Search Strategy Page where, as mentioned earlier, the librarian evaluates the students' searches and gives search assistance to each one individually. Using the rubric (see Appendix C), the librarian assesses and evaluates their searching and their bibliographies; with the first two sections, grades are averaged to show the teamwork values. The lifelong learning skills are assessed through the search strategy form with their individual comments and with personal meetings. Sapp Nelson and Fosmire [19] mapped the ABET and the ACRL criteria. We have matched the CEAB criteria to those in our rubric showing the relationship to ABET accreditation and ACRL standards.

The six stages of the Information Search Process (ISP), introduced by Kuhlthau [20], describe a person's search process as well as their thoughts and feelings when performing their searches, which is reflected in our Search Strategy Page questions. The first three stages of their searching (Task Initiation, Topic Selection, and Exploration) are done in discussions with the professor and the librarian and the final three steps (Focus formulation, Information Collection and Presentation or Search Closure) are with the librarian. An interesting observation by Isbell and Kammerlocher [21] found that narrowing the topic is probably the hardest issue to agree on. We concur and see that many students' reports try to "save the world" with their topic solutions (e.g. electric vehicles, 3D printing on the Moon, cleaning up space debris or desalination of seawater in the Mid-East, etc.), which is often the result of an inability to focus on a manageable aspect of a topic stressed by the professor and the librarian during classes.

5.0 Assessment

The development of assessment tools at the University of Manitoba is a dynamic process involving various levels of consultations – from industry expectations of our graduates to teaching and assessing individual and team work. In 2013-2014, the University of Manitoba held a series of meetings with industry representatives, mainly to make sure that each group uses a common language to describe what industry expects and what the faculty were teaching and assessing [22], [23].

Several universities make their graduate attribute rubrics readily available, such as we do at the University of Manitoba [24]. Our Information Literacy assessment rubric builds on the ACRL and the Engineering Accreditation standards as well as the University of Manitoba's rubrics. Lanziner and Strong [25], for example, have written a paper on rubrics for a capstone design course and assessing engineering design over a three-year study.

Douglas, Fernandez, Purzer, Fosmire, and Van Epps' test [26] comprehensively measures information literacy and lifelong learning skills in an engineering course, and the CELT (Critical-Thinking Engineering Information Literacy Test) is very promising with recommendations for English speaking students and includes recommendations for students with English as an additional language. As well, in 1978, Guglielmino [27] developed a self-directed learning readiness scale (SDLRS), a self-report questionnaire with 58 items that is very comprehensive. There are several other such tools for assessment but, at this time, they are being considered for our class assessments in the future.

6.0 Summary

Assessment using the simple Search Strategy Page involves assessing the students' topic, their individual focus in their section of the final report as well as how and what they have found from searching the Googles, Primo and the databases. It is often the first time the students have heard of or used these sources. The Search Strategy Page, however, is perhaps best suited to a smaller academic library with only one librarian. Our Page is basic and introduces a means of evaluating the initial searching capabilities of our students; it is a place to guide the students' searching, as well as evaluate the teaching content by the librarian. Often a pattern manifests itself in the comments on these Search Strategy Pages where the librarian sees areas that need more in-depth exploring and/or examples for future classes.

There have been critical challenges in teaching information literacy in the past few years with the advent of both big data [28] and fake news and fake video detection in this post-truth era. Indeed, the title of Leetaru's [29] paper emphasizes that fake news is an information literacy problem, not a technology one. As well, there are new uses of information technologies such as the Internet of Things and Tweets that make timely information literacy even more essential. These aspects provide some possible future directions, either as part of the instruction for this course if there is time, or in developing a separate course.

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Appendix A: Search Strategy Page

ENG 2040 Tech Comm --- Search Strategy Worksheet – 2019

➔ HANDWRITTEN WORKSHEETS ARE NOT ACCEPTABLE

Topic: ______________________________ **Name:** ____________________

Date: ____________________ **Team #** ________

Outline your search steps (note databases **and** search engines that you used. Indicate where you have used Boolean logic (AND, OR, NOT). Use the back of the worksheet if necessary. How did you combine your concepts?

1.) **What is your Team's topic?** ______________________________
2.) **What is YOUR aspect of the topic?** ______________________________

Starting search terms? (list here)
Search terms discovered during research session (list here)

<><><><>

Searching: as you explore the 4 resources below, what worked? What didn't? Describe each search process. Demonstrate the **critical thinking skills** you used to **problem solve** your research challenge.

<><><><>

3.) **GOOGLE SEARCH: Give an example of how you searched Google *successfully* for your topic (identify the words, concepts and your limits). Describe the results and relate what you have learned about searching Google for an engineering topic.**

4.) **GOOGLE SCHOLAR SEARCH: using the same concept, but with appropriate search terms, describe your Google Scholar search. What did you learn about searching Google Scholar? Is Google Scholar better than Google for engineering concepts? If so, how?**

5.) **ONE STOP SEARCH: (Summon) Describe your *One Stop* search, try different search terms, and describe your search(es) and the results. What do you think of this for searching for engineering information?**

6.) **ENGINEERING DATABASE SEARCH: (Ei Village or IEEE): Give an example of a *successful* database search (identify your terms, the concepts and the limits). Describe the results and relate what you have learned about searching a database as opposed to using a search engine. Try to use a controlled vocabulary (subject heading) for more a precise search.**

Ei Village/Compendex = more **Mech** or **Civil** Engineering AND IEEE = **Electrical** and/or **Computer**

Appendix B: Survey #2

Group (circle one)**:** A01 A02 A03 A04

ENG 2010, as you know, is a course that highlights the kinds of communication you will be doing as a professional engineer. Because communication is so important to the profession – industry partners, for example, consider it to be one of the top three skills you will need – ENG 2010 helps you to become a more proficient communicator through practice, feedback, reflection and revision. When we started the term, we asked you about your levels of confidence on a number of related items. Now we would like to know, first, how *proficient* you are *right now* in doing the following (use the scales below as a guideline) and, secondly, how *proficient* you believe you will have to be when you graduate:

Levels of proficiency (based on CDIO levels, 2008)**:**

1. to have experience or been exposed to
2. to be able to participate in and contribute to
3. to be able to understand and explain
4. to be skilled in the practice or implementation of
5. to be able to lead or innovate in

Thanks for your input! Your input helps the Faculty of Engineering improve the course. Good luck in your future endeavours.

	Current Level of Proficiency	*Expected Level of Proficiency*
1. writing shorter documents (< 5 pages) that demand that you have an engineering background (minimum of 1-2 years in an engineering program)		
2. writing longer documents (> 5 pages) that demand that you have an engineering background		
3. writing shorter documents (< 5 pages) for readers who do not have an engineering background		
4. writing longer documents (> 5 pages) for readers who do not have an engineering background		
5. choosing and preparing textual illustrations		
6. giving a speech in front of a large group (> 20)		
7. giving a speech in front of a small group (< 20)		
8. giving a speech to people you do not know		
9. giving a speech to people you do know		
10. giving a speech to a mixture of people whom you know and whom you don't know		
11. working as a member of a large team (> 5 people)		
12. working as a member of a small team (5 or fewer people)		
13. working as a member of a multidisciplinary team (both engineering and non-engineering backgrounds)		
14. being a leader on a team so that the job gets done while still respecting the roles of others		
15. contributing to team goal setting and working with others to achieve those goals		
16. evaluating team effectiveness and planning for improvements		
17. identifying your own personal areas of strengths & weaknesses		
18. identifying the means to develop your strengths and eliminate your weaknesses		
19. working to develop broader knowledge		
20. applying critical inquiry and analysis to engineering problems and doing the communications that support the engineering work		

Appendix C: Information Literacy Rubric

ENG 2040 Technical Communication

SEARCH STRATEGY & BIBLIOGRAPHY MARKING RUBRIC

Donald W. Craik Engineering Library

CEAB 3.1.3 – Problem investigation: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions. ←-- **Competency Level** ---→					
	Strong (4) *Applies outcome in multiple contexts. Many strengths present.*	**Competent (3-3.95)** *Shows skill in this outcome. Improvement still needed.*	**Developing (2-2.95)** *Strengths and need for improvement still needed.*	**Emerging (1-1.95)** *Need for improvement outweighs apparent strengths. Evidence of outcome present.*	**None (0-0.95)** *No evidence of outcome present.*
Problem Analysis/Team **Finding Information – topic identification & selection** **(*Search strategy*)** **Investigation/ L.L.L.** **CEAB Criteria 3.1.1-3;3.1.6-7;3.1.9;3.1.12; ACRL 1.1-2;2.1-5;3.3.b;3.6.a-c; ABET 3..a-k [Search Strategy Page averaged from ALL team members]**	Able to clearly and succinctly articulate a topic, to formulate, refine, and implement a complex search strategy, making use of Boolean operators and controlled vocabularies (subject headings). (Information from *Search Strategy Page*)	Able to articulate a topic, but not able to clearly formulate or implement an effective focused search strategy. May use controlled vocabularies (subject headings). (*Search Strategy Page*)	Able to articulate a topic, but the ability to formulate & implement a search is limited to simplistic approaches. Does not use controlled vocabularies (subject headings). (*Search Strategy Page*)	Able to articulate a topic, but not clearly or succinctly. Unable to formulate simple searches effectively. Performs very basic keyword searches (single words and/or simple phrases) which will retrieve unacceptably large numbers of hits. Does not consult the librarian. (*Search Strategy Page*)	Unable to articulate topic at all. Has not attempted searching or the *Search strategy page* is missing. (*Search Strategy Page*)
Investigation/Design **Locating Information (*Search sources*)** **CEAB Criteria 3.1.1-3; 3.1.5-7;3.1.9;3.1.12; ACRL 1.1-2;2.1-5;3.3.b;3.4.g;3.6.a-c; ABET 3..d-j** **Search Strategy Page averaged from ALL team members** **Individual & teamwork** **Lifelong Learning**	Able to recognize and navigate information systems at **micro (e.g. engineering databases)** and **macro (e.g. related databases)** levels. Thoroughly understands the differences between available search tools. Uses search engines in a balanced manner. Appreciates the importance of print and/or historic resources and knows how/when to access them (Doc Del)	Able to recognize and navigate information systems at a **micro** level, but has some trouble doing it at a **macro** level. Is familiar with the major engineering databases, but not those of other relevant areas. Uses search engines adequately. Somewhat appreciates the importance of print and historic resources, but does not always use them.	Unable to recognize and navigate information systems at a **macro** level; somewhat able to do this at a **micro** level. Most sources retrieved through search engines. Aware of historic resources but tends to use newer electronic resources for their ease of access. Searches return unacceptably large numbers of hits.	Is barely able to recognize and navigate information systems at a **micro** level. Unaware of historic resources and avoids using print resources. Does not clearly understand the difference between search tools and consequently has difficulty selecting appropriate databases for searching or using controlled vocabularies (subject headings). Relies mostly on search engine for sources. Does not consult the librarian.	Completely unable to recognize and navigate any information system. Unable to perform even basic searches and does not know how to access information sources after completing a search. Does not consider historic resources at all. Only uses search engines for searches, or the *Search Strategy Page* is missing.

Communication **Analyzing Information (*Quality of sources*)** **CEAB Criteria 3.1.3-4; 3.1.6-7;3.1.9-10;3.1.12; ACRL 1.1-3; 2.1; 2.4-5;3.2; ABET 3.b-d; 3.g-j** **Impact of engineering on society & environment**	Able to analyze information sources based on reliability, validity, accuracy, authority, purpose, currency, and relevance as demonstrated through sources cited in the team bibliography. Sources are balanced and mostly authoritative resources.	Demonstrates the ability to distinguish between relevant and irrelevant information (based on the topic). Does not always evaluate sources for reliability, validity, accuracy, authority, purpose, currency, and relevance. Sources not always balanced.	Is able to find some relevant sources, but includes irrelevant sources in the team bibliography. Rarely evaluates information for reliability, validity, accuracy, authority, purpose, currency, and relevance. Many sources are not authoritative. Sources not balanced.	Sources cited are not clearly related to the topic, and/or show very little breadth, i.e. many sources are from the same journal or web site or are from very general web sites and/or non-refereed articles. Reliability, validity, accuracy, authority, purpose, currency, and relevance are not considered.	Unable to differentiate between relevant and irrelevant information sources. Sources are mostly from general web sites.

	Strong (4) *Applies outcome in multiple contexts. Many strengths present.*	**Competent (3-3.95)** *Shows skill in this outcome. Improvement still needed.*	**Developing (2-2.95)** *Strengths and need for improvement still needed.*	**Emerging (1-1.95)** *Need for improvement outweighs apparent strengths. Evidence of outcome present.*	**None (0-0.95)** *No evidence of outcome present.*
Synthesizing Information (*Annotations and relevancy to topic*) **CEAB Criteria 3.1.6-7; 3.1.10; ACRL 3.1-7; 4.1-4; 5.1-2; ABET 3.b; 3..d; 3.f-i** **Ethics and equity** **Lifelong learning** **Communication**	Condenses and summarizes information well. Grammar and syntax are excellent. Relates the relevancy of each source to the topic and how it is used in the paper.	Able to summarize most sources in one's own words. Grammar and syntax are very good. Relates the relevancy of most sources to the topic.	Able to summarize several sources, but has difficulty making the connections necessary to support the team's argument or discussion. Grammar and syntax are average. Some incomplete or brief annotations.	Has difficulty condensing and synthesizing information from many sources or few are annotated. Tends to either quote directly from sources (**plagiarism**) rather than use their own words, very brief annotations or the annotations do not show the relevance to the team's topic. Grammar and syntax are below average. Many incomplete sentences.	Completely unable to summarize information. Does not make connections between the sources and the team's topic. Grammar and syntax are poor. Annotations missing or some are **plagiarized**.
Presenting Information (*Citation style*) **CEAB Criteria 3.1.6-7; 3.1.10; ACRL 2.5.c; 4.3.a-b; ABET 3.d;3.f-g; 3.i** **Use of engineering tools/L.L.L.**	Communicates findings in the appropriate style Lifelong learning - style and format. Sources are cited appropriately.	Sources are mostly cited appropriately.	Is not always sure how to cite sources. Inconsistent citation method.	Sources are often cited incorrectly.	Does not cite sources.

Accreditation Sources:

CEAB: Canadian Engineering Accreditation Board (2019 Accreditation Criteria and Procedures).
https://engineerscanada.ca/sites/default/files/accreditation/Accreditation-Criteria-Procedures-2019.pdf

ACRL: Association of College & Research Libraries (Information Literacy Standards for Science and Engineering
Technology)
http://www.ala.org/ala/mgrps/divs/acrl/standards/infolitscitech.cfm

ABET: Accreditation Board for Engineering and Technology. (Accreditation Criteria & Supporting Documents)
https://www.abet.org/accreditation/accreditation-criteria/

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