Information Literacy Skills In Engineering Education: An Examination Of The Perspectives Of Faculty And Students Through A Case Study Conducted At Two Universities In Canada And The United Arab Emirates

Roukana Sanjakdar

A Thesis
In the Department of
Education

Presented in Partial Fulfillment of the Requirements
For the Degree of
Doctor of Philosophy (Education Technology) at
Concordia University
Montreal, Quebec, Canada

April 2013

CONCORDIA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

This is to certify that the thesis prepared

By: **Roukana Sanjakdar**

Entitled: **Information Literacy Skills in Engineering Education: An Examination of the Perspectives of Faculty and Students through a Case Study Conducted at Two Universities in Canada and the United Emirates**

and submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY (Educational Technology)

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

______________________ Chair
Dr. S. Betton

______________________ External Examiner
Dr. V. Ahmed

______________________ External to Program
Dr. M. D'Amico

______________________ Examiner
Dr. A.L. Davidson

______________________ Examiner
Dr. V. Venkatesh

______________________ Thesis Supervisor
Dr. S. Shaw

Approved by ______________________
Dr. A.-L. Davidson, Graduate Program Director

June 28, 2013

____
Dr. B. Lewis, Dean, Faculty of Arts and Science

ABSTRACT

Information Literacy Skills In Engineering Education: An Examination Of The Perspectives Of Faculty And Students Through A Case Study Conducted At Two Universities In Canada And The United Emirates

Roukana Sanjakdar, Ph.D.

Concordia University, 2013

Information literacy skills (ILS) have been recognized as critical success factors in higher education (HE). However, there is a dearth of research concerning the nature and development of ILS within different fields in HE.

Existing survey research highlights a problem, namely, faculty believe ILS skills are underdeveloped or insufficiently developed among HE students. This problem is most marked in the hard sciences and engineering. At the same time, there is little evidence that faculty in these disciplines understand how to address this problem, or have a general view that it falls within their purview. This is changing somewhat in the field of engineering now that accrediting bodies have recently focused on ILS competencies and associated life-long learning skills in their new objectives for programs. For the first time, program administrators and instructors will have to grapple directly with this issue.

Yet, little is known of engineering faculty's understanding of ILS skills in general, or specific to the context of engineering, their conceptions of how ILS are acquired or developed and their role in this, the role of ILS skills at different stages in a students' progression, obstacles or challenges to ILS development.

The research reported in this dissertation attempts to provide answers to some of these questions, primarily through online surveys distributed to engineering faculty at two institutions, located in Canada and the United Arab Emirates, supplemented with two focus groups. In addition, students at both institutions were also surveyed with a set of questions similar to those distributed to faculty. Student perceptions are notably absent in the HE literature on ILS. Understanding both faculty and student views of ILS, their significance, nature and development is arguably a critical first step in planning policy and developing effective curricula that address ILS in engineering education.

This is an exploratory, largely descriptive, study may form the basis for further, more focused or fine-grained research including design- or action-oriented research that would involve the development and assessment of actual strategies to support the improvement of ILS.

ACKNOWLEDGEMENTS

The Author wishes to express her sincere thanks and deep gratitude to her supervisor Professor Steven Shaw for his encouragement, thoughtful supervision, dedicated guidance, understanding, inspiration and generous support which made the completion of this research project possible.

Sincere thanks and gratefulness are also extended to late Professor Gary Boyd for his fruitful advice, support, and invaluable suggestions, as well as to Dr. Vivek Venkatesh for his support, and inspiration; and all honorable members of my Supervisory Committee for their support and very much appreciated consideration.

The willingness to share their time, experience, and knowledge extended by my colleagues, friends and the editor who contributed to the value of this work, is gratefully acknowledged, especially my friend Dr. Isabelle Deschmaps.

Last, but not the least, the loving care, understanding, dedication, and support of my friend and husband Professor Sabah Alkass and my sons were indispensable to making the completion of this work possible. I would like to acknowledge the sacrifices they have made as my immediate family to allow me pursue my goals. I love you all from the bottom of my heart; you are the light of my life.

DEDICATION

For the light of my life, the person who loves, supports, and encourages me every moment. The man who breathes with me all the moments of joys, disappointments, and the pain, and believes in me even when I doubt myself. For my husband, Dr. Sabah Alkass, I dedicate this work because he makes it happen. His endless love, supports, inspiration, and patience are beyond life itself. Sabah, without you, I could not pursue any of my dreams including this thesis. I love you for being there for me and for the family.

Most importantly, I dedicate this work to my sons: Bader and Jad who keep reminding me to relax, and always believed in me. I love you with all my heart and soul, and proud of you for your understanding, endless support and amazing encouragements. You always bring me to life, to the real wonderful life of love and happiness.

This dissertation is also respectfully dedicated to my late father, Adel, who had been always very proud of me. Dad, I know you are watching over me now, and I know you were waiting for this thesis as well as my mother, Salwa. Mother, I also dedicate this thesis to you. Your endless encouragements, love, and the values you taught me, always lightened my world. I love you both.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

Introduction

Information has always been a vital component in determining human's capability to survive within society. For example, early, "primitive" man needed to rely on some types of information to locate prey, store food, or find a shelter. Basic as this may seem, it was what was needed at that time to ensure survival. Nowadays, humans need even more information for survival. But today the term "surviving" means much more than finding food and shelter. It includes other behaviors that define how modern individuals thrive in the twenty-first century. It incorporates behaviors such as: finding a job, maintaining employment, participating in civil society, and meeting various societal demands.

Today's society is defined in terms of the information revolution, wherein information is growing exponentially. This unprecedented expansion is driven by a revolution in information technology: the Internet and the World Wide Web (WWW). The Internet is a worldwide web of individual networks operated by government, industry, academia, and private parties. From 16 million users in 1995 it has grown to more than 2,405 million in 2012, becoming a universal source of information (Internet World Stats/stats). New types of networks based on social sharing have emerged, e.g., Facebook with 800 million users worldwide in 2012 (Internet World Stats/Facebook). Mobile smartphones have put instant access to these networks in the pockets of millions of users with more than 173 million units sold just in Q3 2012 (BGR Media, LLC).

As the WWW grew in value due to the positive network effect and large increases in ease of use it has become a more accessible, popular and pervasive media used by different age groups to access, create and diffuse information.

When we are exposed to multiple sources of information coming from different directions and from a range of media, it is plausible that we might end-up losing control and not be able to use this information in an appropriate manner if we do not have the proper skills to deal with this overload. For example, we might not be able to retrieve the required information on time, we might not be able to assess it accurately, or simply we might not use the information in a constructive manner. The popular writer and futurist, Alvin Toffler, had already anticipated, and drawn attention to, the societal effects of information overload four decades ago, in 1970, in his best-selling book *Future Shock,* in which he warned of the consequences of information overload and a "surfeit of choice" in an information-driven, consumer-oriented society.

Numerous skills are required to thrive in a modern post-industrial society (e.g., mastering specific knowledge and practical skills, and developing cognitive skills such as critical thinking, and problem-solving). Democratic societies require that citizens have *Information Literacy Skills* (ILS) to be effective in building their communities.

Understanding the need for information, and the ability to locate information, access different resources and evaluate the information in order to apply it or create new-shared knowledge are the most essential information skills needed in today's rapidly changing world. Clearly, higher-education institutions are supposed to be adapted to develop and graduate students who are capable of building and sustaining modern societies. However, research shows that matriculated students (especially in the sciences and engineering) nowadays may not all have the required ILS.

This problem is the result of several contributing factors bu,t arguably, issues with information and instructional delivery methods are the main ones. In addition to issues pertaining to variations in the definition of ILS there are also issues related to who takes responsibility for the development and evaluation of these skills. In many instances, this responsibility has devolved from the disciplines or the academic programs to a service within the universities provided by librarians or information specialists. This raises other issues related to whether librarians can deliver anything more than one-shot, short duration, generalist workshops – the most common strategy encountered in the field and in literature. There are good arguments against this dominant approach: the skills need to be developed and practiced over time, librarians lack any formal training in teaching or pedagogy, and, a argument can be made that ILS and their use must be examined and taught in relation to the needs and practices of specific disciplines or fields (Lau, 2006).

Of direct relevance to the picture sketched above are the attitudes and understandings of faculty. If ILS are to be addressed in the curriculum, or via any effective strategy, a good starting point is to examine how faculty in different fields views ILS. How important do they consider these skills to be; how do they conceptualize them; how do they believe they are developed and measured; what do they view as within their purview or responsibility; how do they view the contributions of librarians; how do they view their relationship to librarians or other experts in regard to providing solutions to ensure students graduate with sufficient ILS to be effective in society and in the workplace; what are impediments to ILS development that they may perceive; what are they doing currently to influence the development of ILS in their students; do they believe ILS development is already integrated into the curriculum; if so, how, and is this appropriate or not?

This research is guided by a broad definition of ILS to investigate the professor's understanding of ILS in engineering, and how they deliver these skills, as well as identifying the most important ILS that engineering students need before, during and after their programs. A mixed method approach incorporating qualitative and quantitative procedures and techniques was used to acquire the needed information, through interviews, questionnaires, and a focus group. This research included surveys that addressed engineering students' understanding of ILS and their views concerning how they acquire them. In particular, it is interesting and informative to discover whether faculty and student perceptions and conceptions were in alignment. For example, if faculty members believe they are addressing ILS in the curriculum, are students equally aware of this, or do they have a different viewpoint?

Ultimately, this research will help in identifying how to build strong ILS and, perhaps, in the long term, assist students to graduate with the needed information literacy skills for work and in life.

What are Information Literacy Skills?

Information Literacy Skills (ILS) have been identified as critical skills for modern times. They are taught as essential workplace skills within the new knowledge economy, and as abilities that are essential for people to fully participate in civil society. The education literature also ties them to the important concept of "lifelong learning" (ACRL; Lau, 2006; Candy, 1994). Despite the emphasis on ILS, several problems are apparent with regard to our understanding and with practices related to ILS instruction or development. A reading of the literature reveals the following salient points.

There is a lack of agreement concerning exactly what comprises ILS. This presents challenges for the development of curricula and the integration of ILS training or development within all levels of education – k-12, tertiary and higher education. Definitions range from narrow conceptions that equate ILS with library research skills and, or, technical computer-related skills, to very general, broad definitions that basically define ILS as problem-solving skills and cognitive strategies for inquiry. Indeed, depending on the precise definition, there is some controversy regarding the question whether ILS are even, in fact, "measurable" skills (Cvetkovic & Lackie, 2009). (There is, however, a large number of Information Literacy Skills assessment tools including: iCritical Thinking, iSkills, and ICT Literacy Assessment from the Educational Testing Service; Standardized Assessment of Information Literacy Skills from project SAILS, Kent State University, Ohio; TRAILS, also from Kent State, and; the Information Literacy Test developed by James Madison Center for Assessment and Research Studies and JMU Libraries.)

Many definitions from prominent organizations such as the American Library Association (ALA) converge on the concept that IL provides an intellectual framework that governs the processes whereby we recognize that information is needed, and subsequently are able to find, evaluate, understand, assimilate and use such information effectively, for a specific purpose. As such, one might expect that the broad literature on information seeking behavior (based largely on cognitive, information-processing frameworks) would play a significant role within the ILS literature. However, in fact this is not at all the case. Rather, the literature is dominated by Library Specialist perspectives and frameworks and, generally, has a rather limited focus on “bibliographic skills” (cf. e.g., Lua, 2006; Cvetkovic & Lackie, 2009; McCullough, 2006). Chapter 2, Literature Review, provides a comprehensive overview of the history and conceptualization of ILS, including details of the extensive literature concerning the definition of ILS.

Where And How Are ILS Addressed In Higher Education?

Not surprisingly, ILS, like traditional literacy skills, are given less explicit attention at the higher educational levels. The assumption generally is that these skills are acquired earlier and are required for successful completion of a university degree or program. Surprisingly, there seems to be little data concerning questions such as: what is the success of different approaches to the development of ILS; what approaches are used at different levels of education; what are the expectations and perspectives of teachers and students concerning ILS in the curriculum; what variables mediate these expectations; how aligned are the views of employers, professions and education-systems stakeholders regarding the importance and specific composition of ILS?

At the university level, ILS are not commonly addressed as key curricular components, though there are exceptions where schools, and even states (e.g., Colorado), have mandated programs. Faculty, generally, are not trained in teaching these skills. University-level instruction generally focuses on disciplinary-specific content and skills. Explicit strategies, either for teaching or developing ILS separately or for integrating them within the curriculum, are not generally apparent across university-level programs. Tucker and Palmer (2004) note the following dynamic. ILS are considered important “underpinning skills” for learning. Thus, they are believed to be incorporated into the curriculum (or, they are assumed as “given”). Consequently, there is a lack of any systematic approach to defining relevant objectives pertaining to ILS explicitly and incorporating them, appropriately, into the curriculum. The literature review, as mentioned above, includes a detailed review of ILS frameworks and applications.

ILS, seem, in higher education, to be the domain predominately of Librarians or Information Specialists. Librarians' domination of responsibility for the delivery of ILS has different reasons that are presented in greater details in the literature review, but mainly the genesis is that ILS started as library and research skills that were fostered by librarians. Even within the field of engineering education, specifically, there is an explicit assumption that librarians or information science specialists play a crucial role in the development of ILS. For example, Tucker and Palmer (2004), write: "Collaboration between academic and library staff is essential for the effective planning, development and delivery of training and resources to assist students in the development of information literacy." However, several empirical studies show that faculty seem largely ignorant of the role of librarians and report little interest in collaborating with librarians to develop or deliver training, design assignments, or grade work (Eisenberg & Spitzar, 2004; Johnston & Webber, 2003; Leckie & Fullerton, 1999). Yet, paradoxically, some of these same studies, and others, show faculty also favor collaborative approaches in which instructors work with librarians to deliver relevant resources, programs and training!

The Dominant Role Of Library Or Information Specialists

It is understandable that library specialists have assumed the leading role among stakeholders with regard to ILS development among learners in higher education. To begin with, Library or Information Science as a field has expended the most energy defining ILS. Second, development of ILS is viewed as an extension of the teaching of "library" or "research" skills, long the purview of librarians. Finally, Information Scientists or Specialists have staked out ILS as their own concern, perhaps largely to maintain their status or demonstrate their relevance even as traditional bricks and mortar libraries, their contents, and the activities that support and maintain them, become less central.

The prominent role of librarians has, however, has created some issues. To begin with, information specialists are not trained in pedagogy, and the approach the profession most often follows is the development and delivery of one-shot, typically non-disciplinary-specific, short duration workshops. It is not clear that this is an effective way to promote the development of effective ILS. If these skills are, in effect, at least partially coincident with higher-level cognitive skills, then it is likely that a) their development requires concerted learning and practice over a prolonged period, and b) it is necessary to situate learning of the skills at least partially within the relevant, specific domain or field within which the learner will be expected to utilize them. Librarians, save those with specific disciplinary backgrounds to supplement their librarianship training, cannot be expected to understand the use of, or demands on, ILS within a specific discipline. (In the professions, one may also question whether faculty fully understands the needs within the profession, unless they are also involved in professional practice outside their academic roles.)

Despite the evident willingness to depend on library specialists to deliver relevant training for ILS acquisition and development, there is, indeed, some recognition throughout the literature that generic training in ILS has only limited efficacy. Tucker and Palmer (2004) concede this in their article. Several studies (e.g., Hill & Woodall, 1999; Orr & Wallin, 2001) have reported findings that students view generic approaches as lacking relevance. And numerous commentators (cf. Candy, 2000) have acknowledged that “Each discipline has its own unique ‘literacies’, and even within a discipline, ‘information literacy’ may encompass a range of sources and strategies”. Given the lack of evidence of faculty collaboration in the explicit teaching of ILS, and the mixed messages concerning faculty attitudes towards being involved in such collaborations, this suggests a real challenge in developing more disciplinary-focused training of ILS.

Situational Summary

Summarizing the points above, we may conclude that:

a) ILS are almost universally considered critical. There are many definitions, but also some convergence towards a common understanding that goes beyond simply library or bibliographic skills.

b) We know little about how best to teach, develop and evaluate these skills. There are a number of case studies of different approaches in the literature (e.g., Johnston & Webber, 2003), but nothing approaching a systematic examination of the question that could support or motivate widespread adoption of principled, effective practices.

c) A contributing factor to lack of progress may be the circumstance that the field has been conceded to librarians or information specialists, who have little knowledge of pedagogical or psychological principles and constructs related to learning or instruction. Nor are librarians necessarily well-positioned to create interventions that are adapted to the specific contexts of different fields or disciplines.

d) In higher education, according to the few extant studies, faculty seem largely to prefer to concede responsibility to librarians, or to take ILS as a “given”. At the same time, we know little about their own experiences acquiring or using ILS; about their own conceptions of ILS and their acquisition; or their own curricular practices that may be relevant to imparting or developing these skills. And, despite the fact they are willing to concede ownership of the problem to librarians, or to claim preference for a collaboration between librarians and faculty, several studies have found that typically faculty has limited understanding of the role and capabilities of librarians, and show little actual effort with regard to participation in a collaborative approach, and a low stated approval of the prospect of specific acts of collaboration.

e) The “options” have been defined primarily by librarians to include librarians taking responsibility for developing and delivering training, or librarians collaborating with faculty to develop and deliver training – via short workshops and lectures, typically using a generic approach. Another option is to integrate longer courses or assignments into programs of study, or integrate shorter assignments and instructional sequences within existing courses. There are some case studies of such approaches in the literature, but apparently very few (e.g., Feldman & Feldman, 2000). On a larger scale it is not clear where the inputs, resources and necessary expertise would come from. Concerns are also raised about how time could be found within an already-compressed, content-intensive, curriculum to address ILS.

Focus On Engineering Education And ILS

Given the preceding context this research investigated the specifics of ILS from the perspective of both faculty and students – their conception, perceived role and importance, approaches to development. With this premise that ILS should be understood within the context of specific domains (professions, fields or disciplines) the study was restricted to the specific field of engineering. Engineering itself comprises different fields (mechanical, electrical, chemical, civil, etc.) and there are likely important differences between these in terms of dependence on ILS, and the nature of the specific skills that are most crucial or the contexts in which they are practiced.

Engineering offers an interesting case for the investigation of ILS for several reasons:

(1) Engineering fields are increasingly complex and expertise is subject, increasingly, to rapid developments in, primarily, techniques and technology. This is recognized by the profession, and sometimes identified through the objectives named by professional bodies that accredit engineering programs. This circumstance alone should suggest the importance of ILS for successful professional careers (cf. McCullough, 2006). There are, in fact, spectacular

examples of engineering failures where root causes are located in the failure to recognize when new information is needed, seek new information effectively, assess new information, or communicate new information successfully. The report addressing the spectacular disaster with the US space shuttle identifies exactly these failures as the source of the disaster (NASA, 2003).

(2) Existing surveys show that, among fields and disciplines, engineering faculty and students rate ILS as less important than do others. “Hard” science programs rate ILS lower than social sciences and humanities. Among the “hard” sciences, engineering responses place ILS lower than most in terms of importance. Paradoxically, surveys also show engineering faculty is dissatisfied with ILS displayed by students in upper-level or senior courses (Leckie & Fullerton, 1999; Maynard, 1990: Ivery, 1999). It is possible that the specific nature of engineering education – which is heavily dependent on textbooks, especially in the initial years – mitigates against the development or practice of ILS, to a point. Engineering students may have followed, again, textbook-driven approaches to acquiring the fundamentals (largely math and some physics) at previous levels. Thus, engineering may face a particular challenge or situation with respect to ILS. ILS are thus critical for workplace success and on-going professional education and development, but likely not a focus of most engineering education.

(3) With regard to the last point, in (2), above, there has been some suggestion in the literature that engineering needs to adopt a problem-based approach to remedy the situation – analogous to the now ubiquitous approach taken in medical education, developed over the last 25 years (Mills & Treagust, 2003). Others have argued that the nature of engineering knowledge, skills and problems do not lend themselves to a problem-based curriculum. Engineering problems are generally complex and ill-defined – involving the development of solutions that meet many different constraints. The constraints are highly contextual, depending on the aims and resources of different stakeholders. Unlike the sciences or even medicine, the practice of engineers is a form of design activity. Perhaps, though, engineering education could be enhanced with other

strategies such as project-based learning, and possibly this kind of reform could more readily facilitate ILS.

(4) Despite the situation described above, we know very little about:

a. How engineering programs actually facilitate the development of ILS

b. How ILS are implicated in the curriculum

c. What are faculty perceptions of ILS – what are ILS, how do they believe ILS are acquired and developed, how important are ILS in professional practice, what do they believe they are doing to improve ILS, how are ILS currently demonstrated or measured, how can they be measured?

(5) We also know virtually nothing about how student perceptions compare with the faculty perceptions identified in (4) above. Existing survey literature focuses almost exclusively on the faculty viewpoint.

(6) There is much less information and research concerning ILS in Engineering extant than for the social sciences and humanities, or other “science” oriented fields. Yet, the nature of the field and the rate of technological change that impacts engineering strongly suggest the importance of ILS in successful engineering practice.

(7) Not least, accreditation bodies that set the standards for engineering education in Canadian, US, Australian and European universities have begun to include objectives related to ILS in their requirements for engineering curricula. In the absence of specific guidelines or best-practices or best-evidence concerning how to achieve the integration of these objectives, and given the content or knowledge-heavy nature of programs, engineering programs are faced with a serious challenge in terms of curriculum reform and development to meet these requirements. The Canadian requirements are documented in the 2011 Canadian Engineering Education Board Accreditation Criteria and Procedures (retrieved from www.engineerscanada.ca)

Chapter 2, Literature Review, includes more detailed information about ILS within engineering in higher education and the recent research that has been done in this field.

The Research Focus

It makes sense to start with the questions identified in (4), above, if we are interested in laying the groundwork for improving ILS within engineering education. Answers to such questions should inform strategies for integrating ILS into engineering programs more effectively. They should also provide an explanation for some of the perplexing findings within the existing, survey-based literature. As summarized earlier, these include, for example, the perception that ILS are not important combined with the finding that learners are deficient in ILS, especially at the more senior levels, and the view that the best approach is to collaborate with librarians, coupled with a stated intention or preference not to collaborate with librarians.

Adding to this investigation of faculty perceptions and conceptions, it is important to gather the student view, as well. Do they perceive the same things as faculty? Do they detect the same emphasis on, and strategies concerning, ILS as do their teachers? Do they concur with their teachers concerning the nature of these skills and their development, and their importance, at different levels? Do they see the same attention to these skills in teaching, assignments, assessment and curriculum? Do their views pose any challenges, in themselves? What are the sources of their views (the profession? teachers? personal experience?)? What are their perceptions of their own adequacy, or inadequacies, with respect to ILS?

A more complete program of research would investigate not only faculty and student perceptions and practices but also the views of the professional bodies and of employers in the market. This would provide a more complete picture of the situation with respect to ILS in engineering, the scope of any problems associated with ILS, and potential strategies to remedy them. At the very least, a comprehensive approach like this would provide data concerning any disjunction between academic goals and outcomes and required professional competencies; at best it would locate the root of such disjunctions in specific aspects such as student expectations and belief systems, faculty members' perceptions and competencies, entrenched pedagogies, requirements of program accreditations, the changing realities of professional practice in the field.

For practical reasons relating to feasibility, this first study is restricted to an examination of faculty and student perceptions. If successful, the research will expand the perspective in future work.

Genesis Of This Study

I started my research in human information behavior (HIB) by focusing on the phenomenon of people seeking information on line. Studying the different frameworks of HIB made me wonder: Then what? How will I use these frameworks? The answers were not satisfying enough, since I was looking towards making a major contribution in the fields of information science and education -- a contribution that merges these two disciplines together. Following more investigation – further reading and attendance at a variety of conferences and colloquia, and discussion with my committee – the concept of Information Literacy emerged as a higher-level construct that assumed a position of importance across education, human resources development and information science. While human information behavior is an interesting area of inquiry, it is plain that there are more general questions that remain unanswered regarding the larger issue of "information literacy", including its definition, its relationship to specific disciplines, its significance across disciplines and fields of study, and our lack of understanding concerning what methods and policies are best adapted to facilitating the development of skills related to information literacy.

Initial research into Information Literacy (IL) started with reading relevant articles in journals in the broad subject area of information literacy. This initially led to more confusion, since there is not one solid and clear definition for IL. It is clear enough that every IL author who is a librarian adapts the American Library Association (ALA) definition: it is the skills that entail that the individual understands the need for information to solve a problem, is able to access and locate the relevant information, and is able to retrieve the information and use it ethically, to a suitable practical end. It also became clear that librarians dominate the IL issues. This was evident at the ALA conference in Chicago in summer 2009. In every session, librarians were raising the problems of teaching these skills. In particular, they were asking: how to teach these skills through a “one-shot” intervention. Accordingly, most of the presentations and papers were about explaining learning theories and how to use them in the context of designing or delivering a one-hour training session. A further more intense review of books and articles, and information literacy web logs (such as: Webber’s IL weblog), and the IL forum (a discussion group that was formed within ALA) was helpful on one hand and disappointing on another. Most of these books are about teaching librarians learning theories, instructional design and so forth. However, they also discussed the definition of IL while adapting their own “working” definition.

In summary, the weblogs, the forums, the articles in the academic journals, and books about information literacy were the main sources that I consulted looking for materials to form a clear idea about the IL problems and issues. However, surprisingly these publications and information sources did not report any research that has been done in this area. In fact, one of the very few more systematic evaluations or approaches, cited frequently, was the work of Webber and Johnston (2005), who evaluated their full credit course on IL over a one-year period in 2003. Other publications, as mentioned above, are primarily about teaching learning theories and teaching tips for librarians or educators how to teach ILS.

A subsequent search of the engineering and education databases turned up a small number of articles that highlighted the importance of the ILS within engineering, but there was no research to be found about professors' understanding (or evaluating) of the needed ILS in engineering. Nor did any research highlight the engineering students' points of view with regard to ILS, and how they acquire these skills. There are thus very large gaps in the literature. This study here is just one step in trying to fill in these gaps and move the field towards a better understanding of what is required to improve needed ILS of engineering students, and what are some of the challenges and opportunities.

Methodology

The reader may choose to gloss this section, which provides a high-level account of the methodology employed in this research. The subject is treated in detail in the dedicated chapter, Chapter 3 Methodology.

Guiding hypotheses. This research is exploratory in nature. Nonetheless, there are some guiding, rough hypotheses, that inform the study and that remain to be confirmed, disconfirmed, or elaborated. Based on anecdotal experience, and the surveys and evaluation studies discussed earlier, these hypotheses include the following.

1. Professors lack deep comprehensive understanding of Information literacy.
2. Professors lack the needed information literacy skills (or some of them).
3. Professors are not fully aware of the roles of other academic's departments, such as educational technology and libraries, within higher education settings.

4. In case professors acquire the full information literacy skills, they do not master the techniques of teaching these information literacy skills.

5. All the results can be affected by gender, age, years of experiences and background.

6. Certain ILS are needed for different engineering departments, before, during and after attending the classes.

7. Engineering professors do not generally solicit the help of librarians to teach any ILS.

8. Engineering students are not aware of the needed ILS.

9. Engineering students do not know where to go to get these needed skills, in case they are aware of these skills.

Research Questions. Based on the rationale developed above, and the "assumptions" elaborated in the previous section, this study investigates a range of questions through surveys, and small focus group processes, and some review of artifacts (e.g., course and program descriptions, assignments).

1. Do professors fully understand the meaning of ILS as per popular definitions of frameworks in the IL field today? Or, how do they themselves conceptualize these skills?

2. Do professors acquire all the ILS?

3. Are professors aware of the librarians' and other educational or pedagogical services' roles in supporting teaching? Do they perceive any relation or relevance to the issue of developing ILS?

4. Do they ask the help of librarians in teaching ILS?

5. How do they teach students ILS?

6. Do they believe it is their role to teach or develop students' ILS?

7. Do they feel they need to know more about certain ILS?

8. What are the most important ILS in their field?

9. Which ILS, if any, do Professors expect students to have before they walk into their classroom?

10. Which ILS do professors expect students to have when they graduate from their classes?

11. What are the ILS that students should have when they graduate from an engineering program according to the professors?

12. What does “ ILS” mean to engineering students?

13. How do students believe they acquire these skills?

14. What components of their programs are students aware of that they perceive are relevant to the development of ILS?

15. Are ILS evaluated and, if so, how?

16. How important do students perceive these skills will be in their professional lives?

17. What are the most important skills an engineer should have, from the students’ point of view?

Participants. Participants – both faculty and students – were recruited from engineering programs at Sharjah University in United Arab Emirates in Sharjah and at Concordia University in Montreal, Canada.

Research Design. Since this research deals with complicated problems with practical dimensions in education and information science, and since the questions are several and complicated, the best approach is a pragmatic one. Design research arguably might be the most ideal approach. However, this study is limited by time and could not meet various the requirements of certain characteristics of design research – the possibility of altering the methodology during the study, the ability to develop systems or artifacts and implement and observe them, for example (van Akker, 1999; Reeve et al, 2005). For this reason, I chose to use a mixed methodology approach. The mixed method approach can be considered a viable solution as a pragmatic approach that avoids the problems associated with design research.

Essentially, this is a mixed-methods, multi-site case study.

Data collection. Data was collected via questionnaires, and focus groups. There was also some collection and analysis of artifacts, such as assignments, evaluations, evaluation rubrics, course syllabi and objectives, and program descriptions. Collection of artifacts was subject to feasibility, and also an initial assessment of whether these artifacts were in fact able to cast any light on relevant perspectives, practices or assumptions.

Data analysis was both quantitative and qualitative. For example, there are open-ended questions that required a qualitative analysis. Other questions that were developed presented fixed choices and thus could be treated with quantitative analysis. On the other hand, the qualitative approach provided a deeper understanding of the problems, as we explored different points of view, for example, or discovered other unknown dimensions of the problem. For example, an explanation of the professors' feelings and attitudes towards librarians.

Instruments – surveys, and focus groups. The first step in collecting data was to construct the questionnaires, then pilot test them with small groups of volunteers. Once the questionnaires were revised and finalized, they were sent via email to the professors in the engineering departments at Concordia and at Sharjah Universities. For this step, the Survey Monkey tool was used to distribute the questionnaires and collect the resulting data. The questionnaires were available for two months, and invitation emails were sent to the professors, followed by reminder emails and then thank you emails. At some stage, phone calls could remind professors to participate.

The first step was to interview five professors from each university in two separate focus group activities: Concordia and Sharjah. A permission letter to the University of Sharjah's president explained the goal of this research and asked permission to start collecting the data, according to the customs in the United Arab Emirates.

In a second step, after running the pilot study and modifying the questionnaires, a brief letter was distributed to the professors of Concordia University and Sharjah University in the different engineering departments. The goal was to collect between 50 and 100 questionnaires (from among a total faculty complement of about 300). This letter briefly indicated the importance of information literacy skills in academia and in the profession, and how the professors' inputs would be a highly valued step for the future with an aim to better promoting these key skills. The letter also included an invitation to fill out the questionnaire on the website. This letter was sent via emails, personally or by mail. A follow up email reminded professors to fill the questionnaires and a thank you letter was distributed upon receiving their answers.

The same steps were followed with the students' questionnaires. We hoped to collect in the region of 300 student responses. In addition to our own communications with students, we also asked participating faculty to promote the student questionnaire with their students. Students were asked to identify their current courses. This allowed some cross-referencing of faculty responses with student responses. Student responses were anonymous. The last step was to run focus groups in both universities. Around five volunteer professors were contacted for each of two to four focus groups, depending on the response.

In addition to the types of questions presented earlier, the surveys also collected demographic data describing the participants: age, gender, years of academic tenure or seniority, specific academic field, year of graduation, years of work in the profession.

When the survey for the students was ready on The Survey Monkey website group emails were sent to students asking them to participate in the survey.

The last stage of collecting data was to hold a focus group comprising engineering professors where volunteers could share their experiences and own points of views regarding the most important ILS that are needed in their field.

Both the questionnaires for faculty and students, and the interview format, were pilot tested with participants from among the same population from which the study participants were drawn. The pilot test addressed the clarity and interpretation of the items, relevance of the items, and completeness of the instrument.

Responses to open-ended questions were collated and grouped into named categories, following standard content analysis and coding procedures. Two independent coders analyzed the responses and enter-rater reliability was verified.

Depending on the results obtained from the two cases, consideration was given to a cross-case analysis, pinpointing similarities and differences across the cases and the relevant contextual descriptions.

Strengths of the Research

This research investigates important problems related to the engineering graduate's low, or perceived low, ILS level. This problem is rooted in delivering the ILS in engineering and to acknowledging the needed ILS within the field.

Librarians claim that their relationship with the professors is sour, or weak, and, as a result, it affects their ability to deliver ILS to students. Such a poor relationship also prevents librarians from sharing with professors their ILS and it affects workshop attendance.

At the same time, librarians always deliver the same ILS training to all disciplines, apparently on the assumption all ILS are generic. However, increasingly it is argued that engineering has its own set of ILS. Hopefully, this research will highlight what are these badly needed ILS in engineering.

However, through the extensive literature review of ILS and personal observations, a set of hypotheses was raised regarding the needed ILS in engineering.

Accordingly, this research investigated the engineering professors' understanding of ILS in general and engineering ILS in particular, and how they make sure that their students acquire these skills. This research also investigated the engineering students' understanding of ILS they need and how to gain them.

The strengths of this study lie in the kind of questions that were asked, and the type of information that was collected regarding the information literacy skills that are needed in engineering and the methods of delivering it.

Bruce's study (1997) uses the phenomenological method (to ask people what they believe is the ILS) in order to shape a definition of Information literacy skills. Of course, educational and information science professionals have also been building definitions and frameworks that they believe are fruitful and useful, by consensus. It is important both to take the professionally developed viewpoint into account, but also to acquire an understanding of how academics within a specific field define and conceptualize these skills, and, in particular, how they situate them within the requirements and practices of their own disciplines or fields.

Therefore, it was assumed that professors and students have a sense of understanding of ILS, and know what kinds of skills are needed in engineering. In that sense, I measured the understanding of engineering professors and students' ILS in general (according to our working definition of ILS), and then proceeded to try to tease out how they are related to engineering (learning and practice within the field) more specifically. The reason is that we cannot teach these skills unless we understand what they are. Measuring the professors' understanding of IL is the crux of any solution for problems related to ILS delivery systems.

I also investigated whether professors themselves have these skills and what are their views concerning how they are taught or how they develop, and what is their own role, if any, in this process.

Finally, in investigating faculty views, I also explored their perceptions of other stakeholders who may contribute to the development of these skills, and their reasons for collaborating, or not, with these other agents.

Each of these various “angles” on the subject provided valuable context and background understanding which is indispensible in trying to evolve better solutions for developing ILS in graduates.

Weaknesses

The main constraint of this research was the limited time-frame. Scheduling for the interviews with the professors was challenging since professors are busy, especially when scheduling for the focus groups. The questionnaires themselves were available for less than two months. It was a challenge to obtain a high and representative level of participation.

Difficulties were expected in conducting any systematic review of artifacts to complement the self-report data concerning practices. Thus, the study relied heavily on self-reported data. This was less of an issue concerning the analysis of viewpoints, of course, but it was a significant issue with regard to the reliability of self-report of actual practices and strategies.

Finally, it was difficult to assess how representative were the participants. This was inferred, weakly, from available gross demographic data concerning the student and faculty bodies invited to participate. As a case study, even with two quite diverse settings, external generalization was limited, and generalization was dependent on the extent to which a rich account of the views, perspectives and practices could be generated from the research.

Contribution

The situation is quite straightforward. Faculty believe that ILS are important for engineering professionals and, increasingly as they progress through their programs, for students. Yet the perception is that the ILS of students are inadequate. Practicing professionals and the professional bodies that govern the profession do view these skills as critical for success in the modern context of rapidly evolving technologies and the rapidly growing knowledge bases related to the different engineering specialties.

Little work has been done to try to understand how faculty view ILS, how they define them, how they believe they are developed, and what they perceive as their role with regard to developing and evaluating these skills. Even less work has been done to try to pinpoint how students view these skills, what they believe programs and faculty do, if anything, to encourage and facilitate their development with regard to these skills, and how important they perceive them to be for their studies at different junctures and for their future professional lives.

Beyond this, while researchers and practitioners are beginning to acknowledge that ILS must be understood within the different contexts in which they are practiced – the different domains, fields, disciplines – it is also true that there is virtually no research that has sought to identify exactly what ILS are most critical in engineering, and how, specifically, these skills are employed. There are no studies extant that I could discover that use direct observation or direct analysis of artifacts of engineering work to identify what skills are used, when and how.

Given the gaps identified above, it seems clear that a necessary starting point is to examine how faculty and students perceive ILS and their development. This is precisely the purpose of this study. The results may provide insights that are required if we are to figure out how to solve the problem of inadequate or insufficient ILS. Any proposed solution will have to either leverage conceptions that are already predominant in the academy, or will have to incorporate strategies to counter conceptions and attitudes that are, possibly, a barrier to realistic and effective solutions.

Thus, the results primarily will provide an indispensible foundation for curriculum reform of some kind, and for policy development within the field of engineering regarding engineering education, training and competencies. A less direct result, therefore, may be the development of future generations of engineers who are able to contribute to keeping our economy competitive in a global context. The results are also directly relevant to any efforts to promote life-long learning among engineering professionals, given the link so often drawn between life-long learning and ILS.

From the point of view of the information literacy literature, this study will add to the very thin set of studies which examine faculty perspectives and behaviors with respect to ILS in specific disciplines. It will add the students' perspective, which notably is missing from the literature. And it will try to refine the concepts of ILS that are prevalent in a specific field, an angle that is missing from the existing literature.

Structure Of The Dissertation

This dissertation follows the standard model, with separate chapters for Introduction, Literature Review, Methods, Results, Discussion, and Conclusion.

CHAPTER TWO: LITERATURE REVIEW

Any research focusing on ILS must confront several challenges from the perspective of literature. First, the diversity of definitions and conceptions related to ILS is quite broad. Definitions and conceptions range from the very narrow, to very broad. Narrow conceptions include those that equate ILS with “library research skills” or “bibliographic skills” (finding sources, building bibliographies, or with information technology, centering on the use of software tools or applications to search for, retrieve and manage information. Broader definitions focus also on the ability to evaluate information retrieved, in terms of its relevance and credibility, and in terms of the ethical considerations concerning its retrieval and use. The broadest definitions incorporate concepts such as problem-solving, and are quite wide-reaching. In this literature review I will focus on the different frameworks and definitions that are available in the literature.

Second, as mentioned in the Introduction chapter, there is lack of agreement concerning whether ILS skills should be viewed as generic or completely generalizable, or whether it is critical that they be viewed as situated within specific fields or disciplines. The question here is two-fold. On the one hand, do the skills, or the priorities or criticality of different skills, vary across fields of application? Do ILS look different for say, economists versus engineers? Or, at least, is it necessary to approach the teaching of these skills, even if they are essentially generic, with a context-oriented (“situated”) approach.

Historically, the approach taken seems to first to have treated these skills as generic. This is possibly conditioned by the circumstance that professional librarians or information specialists first drew attention to the importance of ILS, and developed the first line of attack on dealing with ILS development in higher education – mostly in the form of generic workshops delivered outside program curricula.

Third, from the standpoint of teaching these skills, there is not much extant in the way of careful evaluations or research of different approaches. There is more literature about one-shot workshops delivered by librarians than any other approach, simply because this is the most prevalent solution. There are a small number of evaluations of other approaches such as the development of a credit-course, or (even more rare) the integration of ILS into the curriculum. In general, the literature is anecdotal or involves Kirkpatrick's level one evaluations (participant reaction). There are hardly any studies that look at the impact of ILS training in higher education on student outcomes or performance within their programs, or that uses hard measures of ILS skills and knowledge acquisition. This is based in part on resources, logistics and feasibility, but also on the lack of participation of researchers who would be able to bring better research and evaluation models to bear. Librarians and faculty across disciplines are not trained in measurement and evaluation, to begin with. The lack of standardized, easy to apply instruments is also a problem. These points are addressed in the Introduction chapter and also in the Discussion. For brevity, literature reviewed in those sections will not be revisited in this literature chapter.

In the study reported in this dissertation we avoided the “measurement” problem, instead focusing on the perceptions of faculty and students concerning the importance of ILS, their conceptions of ILS, and their notions of how ILS skills are acquired.

Definitions

The basic “literacy" skills used to be limited to acquiring both reading and writing skills as well as doing mathematics. Today, literacy goes beyond reading and writing. According to the Canadian Council of Learning (http://www.cclcca.ca/CCL/Topic/Literacy/WhatisLiteracy.htm), literacy is about understanding, using and analyzing information, and applying this information in a performance.

So what is information literacy? Information literacy can be summarized as the skills that an individual should have in order to be able to: recognize the need for information, locate relevant information, access it, and be able to use it ethically.

The rather simplistic definition of information literacy presented above does not identify which skills have to be acquired nor does it capture the complexity underlying this type of knowledge and how it interacts with other skills. However, it is very hard to define information literacy as the definitions given by different research groups are dependent on their beliefs and the skills they see as primary to it. For example, some groups have related information literacy skills to critical thinking skills, or to problem-solving, or to carrying out research. Others might see these skills as a necessity in the daily life. For example, the Conference Board of Canada, in 2000, has published a list of what they consider to be the required workplace skills of the twenty-first century (http://www.conferenceboard.ca/Libraries/EDUC_PUBLIC/esp2000.sflb). The report highlights the importance of these skills in daily working life. Such skills are grouped into three main categories: fundamental, personal management and team working skills. However, each category includes several important sub-skills. For example, the fundamental skills include: communication, managing information and numbers, critical thinking and problem-solving.

In my initial investigations, I gathered the main important skills that researchers across the field have identified (such as: Aydelott, 2007; Bruce, 1997, 1998; Eisenberg & Spitzer, 2004; Johnston & Webber, 2003; Kuhlthau et al, 2008), and use the result as a "working definition" for this research. However, the main independent definitions of information literacy are available in Appendix B.

Towards a Working Definition

Information literacy is a very important issue that deserves our attention as educators. Our modern societies cannot move forward unless people acquire some information literacy skills. These information literacy skills are needed for decision making, and problem solving at different levels.

At one level, these skills are needed to survive everyday life, where people (including seniors, students, educated, professionals, doctors, researchers, and so on) should be able to search information resources, mainly the internet, to service their daily needs, such as the bus schedule, food stores, driving directions, clinics, news update, and so on.

At another level, these skills are needed to solve more complicated problems, and develop a critical thinking through recognizing the type of information needed and how to obtain, retrieve and use the information to construct new knowledge. This sophisticated level is an integral part of creative thinking, innovation and the construction of new knowledge.

But what are these information literacy skills? Examining the information literacy literature reveals that almost all librarians who are writing about this topic adopt the ALA definition of Information literacy. Other researchers, such as Webber, Bruce and Eisenberg, have formed their own definitions. In addition to forming different definitions other than the ALA's, these researchers formulate their own frameworks. Therefore, trying to find a single definition for information literacy is difficult, because, as the literature shows, different sources have their own definitions, and standards. But all these definitions and standards reflect largely the same ideas. This is why I conclude that an information literate person should be able to:

- Recognize the importance of the information in solving any problem, and in making any decision.
- Recognize the need for the information
- Recognize what kind of information is needed in a specific situation
- Recognize the needed information recourses
- Access the information resources
- Locate the information
- Filter the found information resources and judge them while relating them to the main target
- Organize the found information
- Retrieve the information

- Use the information in constructive ways and create knowledge or even wisdom out of it
- Communicate the information
- Be aware of the ethical use of this information while understanding the social, economical and political impact of this information

In addition, for a person to be information literate, he or she should acquire the following skills as well to help in delivering the previous tasks:

- Visual literate
- Media literate
- Computer literate
- Digital literate
- Networking literate

Finally, for a person to be considered information literate he or she also needs to acquire problem-solving, decision-making and critical thinking skills.

Given that there is no single accepted definition, researching information literacy is confusing and, even, tedious. Grassian and Kaplowits (2001) admitted that the information literacy field has this problem but, instead of proposing solutions, they adapt their own "working definition" for the purpose of writing their book on the subject. For them, "an IL individual must be able to effectively interact with information in a variety of situations and to address a range of information needs".

But information literacy is more than information needs and interactions. This account, to me, is more pertinent to library skills or information skills. Information

Literacy skills also include problem solving, decision making, and critical thinking. It is, at the limit, about creating knowledge and sharing this knowledge.

However, Grassian and Kaplowits also tackled a very important issue: is IL a concept? Is it new? Is the name appropriate?

In this context, it is worth mentioning here that the attention to information literacy skills started within the field of library science as library instruction on how to use the library and references, and these skills developed with the progression of the technology revolution to include all other needed skills such as computer skills and problem solving skills. Accordingly, the fields of library science, psychology and information science come together to focus attention on this “new” concept. The historical background sheds light on how this concept has evolved over the years, to become a very important element in the education system worldwide. More details are found in appendix B.

ILS, of course, are not new. People needed those skills a long time ago to survive in different settings (at work, life in general, and academia). But, the range of these skills has changed since the technological explosion that occurred within the last decades. Now more sophisticated ILS are needed such as visual, computer, and network skills. Also, in the past critical thinking, problem-solving and research skills were needed at a high level predominately only by the few -- mainly scholars and decision makers (Messer et al, 2005). Today, the emergence of the knowledge economy, the prevalence of “knowledge” work, and the technology associated with burgeoning information overload require the use of these skills in different everyday life situations, and by a larger proportion of the population.

The question is whether these skills that are associated with literacy should be called "Information Literacy". I believe that it is not suitable for many reasons.

First, arguably, we cannot measure these skills, or at least we have no widely accepted and adopted instrument, so we do not know how many information "illiterates" we have. These skills, unlike writing and reading, are not easily measurable. How, for example, can someone measure reliably whether an individual acquires critical thinking or problem solving skills and determine whether this person is ready to be a learner for life? Second, these skills have different levels. The higher levels are not needed for every single individual to survive, nor even necessarily to be a good citizen in the new democratic societies.

Use of the term "literacy" in conjunction with these skills may well mislead by analogy to the traditional literacy skills of reading and writing. Can we specify the same sort of break-down of information literacy skills into a dependent hierarchy of component sub-skills, for example? Can we measure each sub-skill with the same degree of validity and reliability? Is there anything contextual in nature about the skills or, like reading and writing, are they quite generic?

Related Concepts Of Information Literacy

Information literacy clearly has not always been defined in a consistent manner. Information literacy skills can at times be confused with other terms. Some researchers would even use, mistakenly, these terms interchangeably. However, in order to avoid some confusion, Bruce (1997) distinguished between the different concepts that have, mistakenly, been seen as synonymous with the concept of Information Literacy. These related but distinct concepts are the following:

- Information technology literacy: individuals are able to use all the technologies that are related to the creation and distribution of information such as, computers, printers, IPods, and so forth.
- Computer literacy: where an individual would be able to access and use the computers to deal with information, for example, organizing information, storing information or communicating the information.
- Library literacy: where the individual would be able to use effectively library catalogues, cards, and reference systems to locate and access information. At the same time, one would also be able to search for information using key words. These kinds of skills are usually taught by librarians, specifically where librarians teach what are referred to as the bibliographic skills.
- Information skills: these are widely used as exchangeable with information literacy skills. However, Bruce defines information skills as different from information literacy skills. Information literacy skills are used to create knowledge; meanwhile information skills are just knowledge about information, not skills.
- Learning to learn and lifelong learning: the information literacy skills are the skills that are needed in order to know how to learn, and how to master the self-regulation skills required in order to achieve lifelong learning. For example, lifelong learning requires skills to access information, evaluate information and its sources, organize and retrieve information as well as use this information.

Authors and researchers still commonly conflate literacy skills with other skills such as library skills. For example, Grassian and Kaplowits (2001), in their widely referenced book entitled *Information Literacy Instruction*, adapted a definition for the information literacy skills which comprises the skills that an individual needs to acquire to work with information. But, later in the book, they mainly talked about the library skills and the usage of these skills outside the library. Although they talked about critical thinking, the main focus of their books is on library skills and how to use these skills to store and retrieve information.

Similarly, Eisenberg, Lowe and Spitzer (2004) explained the different kinds of information literacy that, they believe, are needed to have complete information literacy skills:

- Visual literacy means to understand a photograph or a computer illustration, for example, and to link it to your previous knowledge to create a new knowledge. In that sense, visual literacy is about visual learning, thinking and communication.
- Media literacy: understanding the effects of the different media such as television, radio, magazine on our daily life. And have a better critical mind about the different affects that media creates.
- Computer literacy: to be able to work with the different software that helps the individual to create documents and data.
- Digital literacy: being able to use the different digital resources in effective way such as e-mail.

- Network literacy: this is more related to the computer literacy where the individual would be able to locate access and find the needed information on the Internet or other networks (e.g., intranets).

Eisenberg and al. stress very important skills in the Information Literacy skills' shell. These skills of: visual, media, computer, digital and networking skills are essential in this new information era.

Issues in the Field

A review of the literature on information literacy has identified a few problems that have plagued the transmission of Information Literacy skills. However, the main problem is that students graduate from higher education settings with inappropriate (low) standards of the needed ILS. Although today's students are born within the information technology age and are familiar with its usage, they start their higher education with limited preparation for ILS (Trussell, 2004). That is why some graduate students will have difficulty finding a job or keeping their jobs. While it is often taken as a given that students are able to function comfortably with information technology, and with information, especially within the sphere of education, this assumption is not always borne out (see, for example, Bennett, Maton and Kervin's recent article (2008) entitled *Digital Natives, Not so Fast)*.

Tracing this problem to its roots exposes the problem associated with the delivery of ILS, the very issue that has become the main focus of attention of different researchers. McCullough (2006), for example, highlights the main successful methods utilized to deliver ILS within universities. This focus is appropriate, given the fact that in

2000 ABET (the American Accreditation Board for Engineering and Technology) considered ILS are one of the most important skills that students should have (Trussell, 2004). Tucker and Palmer (1999), in an earlier publication, identified various ways ILS could be conveyed, including both face-to-face and online modalities.

Nevertheless, the reality is that librarians have been always responsible for teaching ILS, because ILS started within the libraries as, essentially, library skills (Trussell, 2004). Nevertheless, librarians have not been able to deliver these skills effectively, for a variety of different reasons:

1. Teaching ILS requires collaboration between librarians and the faculty members (Trussell, 2004). But surveys and anecdotal evidence indicate this collaboration is not very common or strong. There are few examples in the literature of approaches that involve such partnerships.
2. Librarians accordingly decide to work unilaterally, doing workshops, mainly teaching IL skills in one-hour, one-size-fits-all sessions. This is very ineffective.
3. Librarians lack the required teaching knowledge, pedagogical expertise, disciplinary knowledge, and experience to devise and deliver effective programs to develop ILS in students from different disciplines
4. Librarians teach all students the same ILS mainly focusing on library and research skill.

The library science literature concentrates on communicating to librarians how to teach these life-long ILS in a one-hour, one-shot session. It is unprofessional, or unrealistic, to teach such important skills like problem solving and critical thinking, or visual or computer literacy in a one-hour one-shot format. At the same time, librarians complain that professors do not fully cooperate with them in teaching these ILS, and do not include them in the classes or academic programs.

All these issues underscore the idea that there is a main disturbing problem within the higher-education settings leading to the circumstance that graduated students lack some of the important ILS. Who is responsible for transferring these skills, and teaching them? How can the skills be integrated into the curriculum? How can they be developed and how can they be evaluated?

We also see that the decision makers in the higher educational settings do not include teaching ILS in the curriculum, except for the cases of a few universities. The main problem here is: who is responsible for teaching these important skills? Professors or librarians?

We need, first, to focus on the problem of the ILS from the professors' point of view, a viewpoint that is lacking from the wealth of literature generated from the library and information specialties. What do they understand of IL? What kind of skills do they expect the students to have before, during and after the class, plus at the moment of graduation? We need also to understand what these professors presently do, or believe they do, in order to facilitate learning these skills by their students.

It is also important to take into account the reality that the important ILS vary, in some ways, from one discipline to another. Librarians do not distinguish among these skills across fields or disciplines. That is why it is important, also, to recognize how important different ILS are within the field of engineering specifically or how they are typically used in context.

But what is the students' position? Are they aware of the ILS they have to acquire: before, during and after their studying years? And where do they study and develop these skills? This is also an important perspective that is not addressed in the literature.

History and Background of the ILS Movement

Information literacy was popularized in the USA in the 1970s, after a call was made to promote information literacy as needed skills for democratic society. It was Zurkowski who first used the term "Information Literacy" in 1974, in a report to the US National Commission on Libraries. He linked knowledge growth to the rapid technological changes, and to the need for life-long learning. In his report, he highlighted the importance for an individual to use the information tools to solve problems (Bruce 1997; Johnston & Webber 2003; Eisenberg, Lowe & Spitzer, 2004). The concept of life-long learning itself was hardly new. Roe (1965) and others in the 1960s were already talking and writing about lifelong learning and the skills that need to be acquired.

Perhaps the crucial starting point for information literacy as a field occurred in 1989 when the American Library Association (ALA) stated (as mentioned earlier) in its report that: (Bruce, 1997; ALA website; Eisenberg, Lowe & Spitzer, 2004)

> *Ultimately information literate people are those who have learned how to learn. They know how to learn because they know how information is organized, how to find information and how to use information in such a way that others can learn from them.*

In the following year, 1990, Breivik formed the *National Forum on Information Literacy* (NFIL) (Rockman, 2004, Eisenberg, Lowe & Spitzer, 2004). Based on the ALA awareness of information literacy, the NFIL was created and subsequently united different organizations that share an interest in information literacy. Over 65 governmental, educational organizations and businesses have been meeting regularly under the leadership of Breivik to promote information literacy in different sectors, including higher education settings as well as in the public domain.

In 1995 the Association for teacher-Librarianship in Canada created the students' *Bill of Information Rights* (Eisenberg, Lowe, & Spitzer, 2004). This bill emphasizes the students' right to master the skills required to:

> *access all different information sources, carry on research including reporting, evaluate, synthesize and use information, use information creatively, understand the Canadian culture and heritage, enhance their reading habits while exploring the values of the other worlds, and finally to think critically and make value decisions.*

Furthermore, the University of Calgary in Canada formed the Information Literacy Group (Eisenberg, Lowe & Spitzer, 2004) to help the university in planning the integration of information literacy skills within the university. The group stated that an information literate student needs to:

> *Realize the need for the information, experience how to access the information and how to evaluate it, be able to synthesize it and then communicate the information.*

Academic librarians have always played a vital role in higher educational settings. In 1987, the University of Colorado and the University of Columbia sponsored a symposium and produced a report that highlighted the importance of information literacy skills in higher education. This report outlined the skills that students need in order to become self-directed independent learners -- a goal which arguably should be the main objective of the university:

Since the late 1980s, the movement concerning information literacy has spread all over the world and in different organizations and sectors. For example, in Australia, Candy, Crebert and O'leary (1994) believed that acquiring information literacy skills is a must for lifelong learning.

> *Access to and critical use of information is absolutely vital to lifelong learning, and accordingly no graduate -- indeed no person -- can be judged educated unless he or she is information literate.*

As a result, in 1997, The Australian Library and Information Association (ALIA) formed the Information Forum. Christine Bruce, who is one of the most famous figures in the information literacy field in Australia, developed the framework of information literacy that will be explained below (Bruce, 1997, 2000; Eisenberg, Lowe & Spitzer, 2004).

Similarly, in 1992 Behrens and, in 1995, Agevers from South Africa related the information skills to lifelong learning.

In the same line Olen, in his 1995 paper, which was presented during the annual conference of the international association of school librarians, proposed a project that could help teachers acquire information skills that they could transmit to their students to help them to locate, select, organize and present the information (Eisenberg, Lowe & Spitzer, 2004).

The information literacy movement has also progressed or grown on the other side of the Atlantic. For example, the United Kingdom (UK) has adopted guidelines to foster the development of these skills within different sectors. In the 1980s, the British Library's research and development committee encouraged research concerning information skills.

Other European countries also followed in the UK's footsteps. For example, in 1994 the Ministry of Education in Finland formed the Expert Committee, which published its strategy in 1995 emphasizing the students' rights to acquire the skills to manage and communicate information, as well as teachers' and adults' rights and obligations.

The United Nations also emphasized the importance of information literacy through the guidelines adopted for training school teachers in the library and information skills (Bruce, 1997).

Information Literacy Research: The Main Frameworks

Regardless of the problems identified earlier in this dissertation, the fact that librarians are leaders in promoting information literacy skills still remains undisputed. In fact, librarians use theories and different frameworks from other disciplines to build their own frameworks for information literacy. Information science, education, and psychology are the main disciplines that are borrowed from, to assist in building information literacy frameworks. In the following section I provide a summary of the major frameworks presented in the literature.

1. Kahlthau's Model. Kahlthau created the information-seeking model that is used in teaching information literacy skills by using concepts from other disciplines. Kahlthau's model is a good example of using information science to enhance the information literacy skills. (Incidentally, the Ontario education ministry uses her model). This Information seeking model has different steps (as taken from Eisenberg, Lowe, & Spitzer, 2004):

1. Initiation
2. Selection
3. Exploration
4. Formulation
5. Collection
6. Presentation
7. Assessment

Kahlthau's model was the end product of a series of five studies that spanned over five years during the mid-1980s. These studies were designed to observe and tabulate emotions that students (mainly high school level) experienced while seeking information. She noticed that students at the initiation stage felt anxious and were uncertain. While students continued their search, this uncertainty went away, decreasing the level of anxiety (Eisenberg, Lowe, & Spitzer, 2004).

2. The "Big Six" Skills. Eisenberg and Berlowits formed their own information problem-solving model and called it "the big 6". The big 6 was created to teach information literacy skills to students who are at different points in their academic lives (including students in higher education settings). However, it is also important to note that this model can be used within industrial and training sectors. This model has the following steps, as taken from Eisenberg, Lowe, & Spitzer (2004):

1. Task definition
   a. Define the problem
   b. Identify information requirements
2. Information-seeking strategies
   a. Determine range of sources
   b. Prioritize sources
3. Location use
   a. Locate resources
   b. Find information
4. Synthesis
   a. Organize
   b. Present
5. Evaluation
   a. Judge the product
   b. Judge the process

This model was the direct end-product of research (and observations) wherein researchers found that most people already use this model without being aware of doing so.

This model has been widely used within school boards and industries. However, it has been criticized for being too superficial -- lacking important details which would impede its implementation in higher-education settings.

3. Bruce's Rational Model. Bruce's model is considered Australia's contribution to the information literacy literature (Eisenberg, Lowe, & Spitzer, 2004, Bruce, 1997). This model is the result of a study that took place within higher education settings in Australia. Christen Bruce asked faculty members from different disciples about their understanding of information literacy. Bruce found that information literacy could be seen as (Eisenberg, Lowe, & Spitzer, 2004):

- The information technology conception: information literacy seen as using the technology to retrieve and communicate information
- The information sources concepts: it is the about finding the information
- The information process conception: how the information is processed
- The information control conception: it is about controlling the information
- The knowledge construction conception: constructing own knowledge
- The knowledge extension conception: gain new knowledge
- The wisdom conception: using information so others can benefit

4. ACRL Information Literacy Competency Standards for Higher Education. According to the ACRL document, students in a higher education setting should acquire the same basic information literacy skills (i.e., recognize the information needs, its sources, how to organize it and use it) in addition to the global perceptions of the different information issues such as information ethics. Students are expected to use this information to solve problems, to accomplish goals that are related to the global issues with ethical implications (Eisenberg, Lowe, & Spitzer, 2004). In other words, the ARCL document determines that students should: realize the needed information, access this information and evaluate the sources and the information critically, use this information to serve a particular goal while understanding the ethical issues involved.

5. ALA: Information Literacy Definitions and Standards. The first well-known definition that introduced the concept of information literacy was provided by the American Library Association's (ALA). In 1989 the ALA's president defined information-literate citizens as individuals who "recognize when the information is needed and have the ability to locate, evaluate, and use effectively the needed information" (Johnston & Webber, 2003).

He further explained: (Bruce 1997, Eisenberg, Lowe and Spitzer, 2004):

> *Ultimately information literate people are those who have learned how to learn. They know how to learn because they know how information is organized, how to find information and how to use information in such a way that others can learn from them.*

Accordingly, ALA through its branch, ACRL (American College and Research Library), sets the standards for information-literacy applications. These standards, which are explained below, are adapted by many higher-education institutions.

Furthermore, ACRL offers, through its webpage, extensive information about information literacy including its standards. ACRL encourages educators to adopt these standards in order to help individuals acquire the needed information skills.

ACRL defines the information literacy as "the set of skills needed to find, retrieve, analyze, and use information". In other words, according to ACRL, information literacy is represented by the skills an individual must have in order to recognize the need for information, identify the different sources where that information can be found as well as locating that information, retrieving it and using it accordingly.

ALA also highlights the importance of technological skills in supporting information literacy skills. In fact, the National Research Council in its 1999 report promotes the use of technological skills as part of information literacy skills (ALA website for information literacy competency standards for higher education, 2000).

ALA (2000) also highlights that different disciplines might need different information skills, and encourages educators to always look back at the "educational goals to determine how information literacy would improve learning and enhance the institution's effectiveness."

6. Doyle's definition (1992). In 1992 Doyle published the results of a Delphi study, where an information-literate person was described as someone who (Eisenberg, Lowe, & Spitzer, 2004):

> *Recognizes the needs for the information and its importance in decision making and forms questions accordingly. He/she also identifies and be able to access the different information resources and forms a search strategy. Then he / she evaluate the founded information, organize them, integrates them into the existing knowledge and finally uses these information in critical thinking and problem solving.*

Doyle, in the Delphi study, asked a panel of experts from the National Forum on Information Literacy (NFIL), a series of questions regarding the meaning of information literacy as they see it. He concluded that information literacy is (Bruce, 1997) "the ability to access, evaluate and use information from a variety of sources". At the same time, an information literate person:

- *Recognizes the need for information*
- *Recognizes that accurate and complete information is the basis for intelligent decision-making.*
- *Formulates questions based on information needs*
- *Identifies potential sources of information*
- *Develops successful search strategies*
- *Accessed sources of information, including computer-based and other technologies*
- *Evaluates information*
- *Organizes information for practical application*
- *Integrates new information into an existing body of knowledge*
- *Uses information in critical thinking and problem solving*

7. Johnston's & Webber's Definition. The point of view of Johnston and Webber regarding information literacy reflects concepts prevalent with European or, even more, UK sources. Over the years, the UK has devoted a lot of attention to information literacy issues through recommendations and standards which have been adopted throughout higher education institutions. In this regard, in 2000, the UK National Inventory Board defined the information society as: "a society in which the creation, distribution, and manipulation of information has become the most significant economic and cultural activity" (Johnston & Webber, 2003).

Accordingly, Johnston and Webber see information literacy as:

> *...the adoption of appropriate information behavior to obtain, through whatever channel of medium, information well fitted to information needs, together with critical awareness of the importance of wise and ethical use of information in society.*

Information Literacy in Engineering

Why Engineering? This research focuses on IL in engineering for a number of reasons, as explained previously.

Engineering science is considered one of the backbones of life in today's societies. Engineering – with its different varieties of specialties of civil, mechanical, electrical, software engineering, computer, chemical, architecture, petroleum, biomedical engineering, oil, aerospace, aviation, communication, and more -- touches every aspect of our lives.

- Engineering is a field that is essentially a "design-oriented" domain of activity. As such, problems are somewhat ill-structured, and problem-solving skills, which many include within the broader domain of information literacy, are crucial.
- Engineering has seen an explosion in terms of new specialized sub-domains, and the field in many of these sub-domains evolves very quickly. Therefore, the onus on practicing engineers to find, access, and absorb new information is quite substantial. Life-long learning and development in the profession, apart from project-based, timely or just-in-time learning, takes on a new urgency.

- Engineering education itself has something of a disconnect with practice, given that, at least at the lower levels of undergraduate education, the problems which are addressed are largely "idealized" or simplified with respect to professional, real-life engineering challenges. Also, students work problems essentially individually, while in practice engineering is fundamentally a team-based activity.
- Engineering education is largely textbook driven, again especially at the lower levels of undergraduate study. Therefore, there seems to be limited accommodation, or requirement for, practice that would lead to improved ILS. At the same time, faculty seems to recognize that ILS are important and that students graduate or reach upper levels of their programs without having acquired sufficient facility with ILS.

Finally, McCullough (2006) summarizes the importance of IL in engineering quite succinctly:

> *The skill set implied by the ALA standards is especially critical for engineers. As one author observed, many engineers lack skills in accessing and retrieving information. Yet the ability to monitor, access, retrieve, evaluate, use, and communicate information will be critical in a global information society characterized by rapid technological change. Engineers who possess a more thorough knowledge of information retrieval strategies and information resources will be more effective in educating themselves, will develop more creative solutions to problems, will practice more efficiently, and will be more competitive in the global economy.*

The Problem of IL Development in Engineering

Teaching ILS in engineering education: the delivery methods. Although there are a few frameworks for teaching information literacy skills, as mentioned above, such as the Big 6, ARCL standards, Bruce's seven faces, the seven pillars (of U.K.), and so forth, many authors (Hepworth, 2000; Wobber & Johnston, 2001; Buschman and Warner, 2001) have highlighted that there is a big gap between the needed information literacy skills as outcomes, and the skills that are taught in the higher education settings. Such a gap creates the unsatisfactory level of information literacy skills within the graduate students, and is attributable to different aspects such as: curriculum, teachers, materials, and environment. In addition, introducing information literacy skills into the curriculum is very young, relatively. It started recently, especially after the ALA presidents defined the literate person, in 1989, as the person who can access, judge, store, retrieve, and use information.

Accordingly, teaching ILS has seen limited attention in the published research addressing higher education. However, the recent years, 2010-2013, witness a rise in the number of these publications. Most of these publications describe the faculties' and librarians' experiences in introducing any form of ILS workshops, seminars, programs, or courses to the students. Although the current research does not seek to validate, necessarily, any particular approach, this literature is worth addressing in the broader context of our subject, and the motivation for the current research -- which turns on the lack of attention to ILS in engineering education and the perceived consequences of this lack.

McCullough (2006) highlights the different methods to deliver ILS training for engineering in higher education. He identifies three means:

a. Introducing IL through full curriculum reform. But this is a difficult approach since professors have little time or, possibly, motivation, to formulate the whole reform.

b. Providing dedicated courses for information literacy skills. Although some faculty members agree on the benefits of such an approach, the semesters are already packed with required courses. York University is one of the very few institutions that reports following such an approach. (The feedback reported is positive.)

c. Integrating the teaching of IL in engineering within existing course. This, according to McCullough, is the best approach, because practicing ILS has to be within related activities in order to maximize the benefit.

Tucker and Palmer (1999) have suggested that online information literacy instruction is the best approach for engineering students, since they are always busy and they can reach for the needed information at any time. However, they concur with McCullough in suggesting that the best approach would be to integrate the teaching of ILS within the curriculum so students will have the maximum benefit, and relate the materials to the engineering specific topics they are studying. Again, they cite time constraints and pressures on the curriculum to cover engineering related content as obstacles..

Feldman and Feldman (2000) similarly recognized the importance of ILS for Mechanical engineering students. They worked on designing materials to enhance students' information research and communication skills, but they had a problem to fit these materials in the curriculum:

> *One problem faced by the authors was to develop strategies to integrate these skills into a curriculum that is already very demanding without deleting any of the elements in the current curriculum. A pre-test, post-test, and student comments supported the usefulness of the assignment.* (Feldmann & Feldmann, 2000)

Douli and Mandhl, (1996), tried to raise awareness of the importance of the computer skills for the engineering faculties through highlighting the most important academic benefits of the web for the engineering, urging the engineering faculties to polish their skills and consider seriously using the web as an academic tool.

Ercegovac's 2009 study reported on the knowledge of undergraduate engineering students of information sources and access. The authors highlighted that there is a lack in the literature review regarding information seeking patterns among undergraduate engineering students, and there are no standardized assessment instruments found regarding accessing content knowledge based on ILS.

Meanwhile, Ali et al (2010) also highlighted that engineering students lack the needed skills to search for information, or choose the appropriate information source. The authors analyzed the citations of the students project's assignments' bibliography of diploma engineer students who studied at least three semesters in a Malaysian university. The authors also used a 20-question survey that using the ILS definition. The results reflect that students' ILS need to be improved including identifying search strategy, evaluating internet information, and using information ethically.

Similarly, Bolitho and O'Luanaigh (2012) measured the undergraduate engineering students' ILS level through analyzing the citations provided for their assignments. They found that students mostly used the Internet free access resources, which are not related to the library. In addition, they found that the students did not benefit from the IL sessions that the library offered. Denick (2010) also evaluated students' ILS through analyzing their assignments' bibliographies. He concludes that the majority of the engineering students use the web sites as information resources and a very few of them used books.

Other authors reported their experience with teaching ILS. For example, Hepworth (2000) believes that ILS could be taught as separate skills, such as looking for the related information sources, or could be integrated within the curriculum, and be taught through using problem-based learning, much as with other problem-solving skills.

Webber and Johnston (1999, 2010) also looked at how ILS could be integrated into the curriculum using problem-based learning. They designed a credit-bearing class for the first time in 1997/1998 in Strathclyde University. The course was an optional three-credit one-semester course, offered for students from different disciplines, and run by the information science department and the center for academic practice in the university. The aim of the class was to introduce to students the basics of information seeking and communication skills to enhance their performance in the workplace and in life generally. The teaching strategy involved students with the learning process through engaging them with assignments in groups while their individual works recognized through participating in on line discussion using the concepts accurately. The course has been offered over many subsequent years with claimed success, but no hard data concerning impact on student performance or acquisition of skills is reported.

In the same vein, the action plan by Fitzwter and Geesaman in 2003 outlines a few models as follows:

1. Students attend an IL credit course that provides the basic knowledge and skills that they will use in the other courses.
2. Or the course integrated model: where IL is the outcome of the core course and the professors sets activities for the students that are interwoven with the course objectives. The instructor may use the help of a librarian, and the evaluation would be through writings and presentations.

They further highlighted that ILAC (an Information Literacy Across Curriculum program) strongly recommends the second model, where professors need to integrate activities within the course, so ILS would be part of the course outcomes. The authors described how ILS is typically taught -- where librarians hold a 50 minutes instruction session to diverse students and where faculty members might get involved in planning the students' activities. Online tutorials (through the library) are another way to instruct students about ILS, including workshops on different research topics, noting that some faculty teach these research skills in their classes. Such a library-centered program is based on a strong partnership with a discipline's faculty. The authors claim this approach is successful. However, the evaluation tools required to validate such claims are not employed. In most cases, only a survey with students' satisfaction level is measured.

Similarly, Fosmire (2011) presents a conceptual model for teaching the ILS for engineering students. Fosmire adapts Kahlthau's IPS model of ILS that contains the seven steps of seeking information that are paired with emotions, and translates it to engineering needs in solving problems. He is hoping that engineering educators would be able to recognize the students' problems in each stage and refer it to the engineering librarians who will work to equip the engineering students with the needed skills for the recognized stage.

Poirier (2005) also reports the experience of the engineering college in the Queensland University of Technology towards equipping engineering students with the skills to think, articulate their thoughts and connect to other minds while critically analyzing a body of knowledge. He highlights how the FBEE, (Faculty of Built Environment and Engineering), provides an ILS framework that works with a program component like their thesis requirement that is offered to the fourth-year students. This framework has been developed through the last decade, with the cooperation of the university library, information literacy coordinator and the information literacy advisory teams. The framework is about integrating ILS in all engineering studies through workshops. For example, the course BNB007, was created for the first year students to integrate core generic skills to encourage students to communicate, research, organize, solve, and present information. The engineering school keeps working on integrating IL teaching within the curriculum. In the CEB411 Thesis, the forth year students are introduced to how to conceptualize and conduct research and development. In CEB411 students select a research topic and with a supervisor come up with a problem relating to the topic. Throughout the course, students learn how to define problems, express and communicate complex ideas while using tools such as concept mapping, develop their ability to retrieve information and search for information, and develop their technical information seeking skills (including using controlled languages and Boolean operators), and information search strategies. Students are also encouraged in developing more sophisticated critical thinking skills and presentation skills. In addition, the institution's Division of Technology, and Information and Learning Services provides support for the students through assisting them with their academic skill developments in critical thinking, academic writing, and so forth. CEB411 includes also a web site, IL workshops and IL tutorials and citation and referencing consultation. Two workshops for literature review are provided and a series of ILS tutorials are scheduled (10 students max in each session). Also, a personal consultation is offered until students are satisfied with the literature component of their research report. Both the supervisor and the librarians offer feedback.

Repanovici et al, (2008) report on the program "documentation techniques" that is a problem-based learning program offered over the last four years to the first year engineering students. The program requires students to work on an engineering project, in addition to conducting information search exercises and attending writing tutorials. The project took place in Transylvania University's library in Romania. The project (Brasov Model of Engineering Learning) has several distinct elements or courses, including a writing tutorial, evaluation of resources, searching OPAC library resources, finding specific articles, ethics in research, standards and patent search.

Fjallbrant and Levy (1999), from Sweden and the UK, present their experience with the DEDICATE distance education information course with access through a network project funded by the European Unions' Fourth Framework Telematics for Libraries Networks project (for libraries program) that ran from 1998 till 1999. The DEDICATE project aimed to develop distance education courses for IL in technological universities in Estonia, Hungary, Latvia, Lithuania and Poland. The project addresses: motivation, activity, interaction, feedback, and knowledge base. The project aims to train the trainers (librarians and academic staff) and requires them to reflect on IL while designing a suitable course for their students. The course uses the Internet to provide communication between individual participants and tutors, and within participants groups, in addition to supplying supporting documents. Participants in the project were to be party to professional continuing education about how to design IL courses for library users in HE sectors.

Roberts and Bhatt (2007) describe a major educational initiative by the Drexel University engineering librarians who participated, during the two terms of 2005-2006, in the Freshman Engineering Design Sequence course, where they employed active learning techniques and technologies to improve the students' educational experience. The course focuses on the engineering design where students receive lectures, and collaborate in groups for a year-long, design project (requires research, clear thinking, exploration of alternatives and revision from the class -- all needed in good engineering design and writing). The course includes a sequence of classes focusing on English composition in humanities including technical writing and research skills (humanities 107-108). In addition, the course teaches engineering (101) that provides engineering materials in design for all of the first year students. After that course was offered, the engineering department is making a change towards tDEC, the Drexel Engineering Curriculum, which will progress integrating ILS materials within the engineering topics.

Welker et al, 2010, report the updates on the IL modules that are integrated within the curriculum in the engineering department at Villanova University. The engineering faculty, with the help of the librarians, developed a course to integrate ILS materials alongside with the engineering content, on the premise that integrating ILS with the requirements and objectives of subject-oriented courses is a better approach.. The authors also highlighted the twenty-six outcomes, based on ACRL, that are created for each year of study within their curriculum. They placed ILS modules into the three years of engineering classes with relevant assignments, for five courses. The instructions and assignments are directly related to the outcomes that are provided in the classes by the science and engineering librarians. The students are evaluated through quizzes, assignments, and surveys. The ILS materials introduced in each class build on the previous ones and progresses to address more complex content and outcomes.

Feldman et al 2000, report a case in which a mechanical engineering professor collaborates with an academic librarian to design a project to increase students' information research skills, their awareness of other sources of technical info, and their communication and team-building skills. The challenge was to include such materials within the full engineering curriculum. This papers discuss the students' experience of this program where the assignment's goals were to make students aware of technical information, acquire basic skills to locate the needed information, encourage team work, prepare students for oral presentations and encourage students to dig into subjects that are of interest to them. The students are freshmen and have to select and research a project. The professor discussed the topic with them and the librarians helped establishing the scope of the research. The article reports that the quality of projects and presentations was enhanced through this approach.

What are ILS in Engineering?

A number of researchers (Tucker and Palmer, 1999) have argued that ILS should be approached with a disciplinary perspective. This would mean engineers should acquire a specific configuration of skills and, or, that ILS would be practiced and employed in specific characteristic ways within engineering fields. Still, there seems little elaboration of this idea through research in the field of IL within engineering. Other researchers seem content to refer to ILS in general, as generic competencies. Messer, Kelly and Poirrier (2005), for example, explain that engineers need ILS (as conveyed by the ALA definition) besides the technology skills. They also added writing, critical thinking and communication skills in addition to the professional standards to form the ILS for engineers. But Messer *et al* did not go deeper to investigate these ILS in engineering; rather, they just reported that accreditation of engineering has started to require these skills as part of the engineering curriculum.

In the same vein, Gadd, Balwin *et al* I n 2010, recently highlighted the importance of ILS in engineering but the focus of their research was mainly on citation. They conclude that citation is a very important skill for engineering in a way that it affects the results of the projects the student has been working on. In fact, few researchers have highlighted the importance of ILS that are needed in engineering. Moreover, in most cases the ILS that are addressed are related to library skills such as finding needed information and using many resources. Or, they are expanded to encompass communications and a broad perspective on engineering and its interfaces with society, culture and the natural environment. For example, Messer *et al* in 2005 reported how Lowe (1997) highlights the importance of generic ILS in engineering: graduates should have "the ability to communicate effectively, not only with engineers but also with the community at large, and an understanding of the social, cultural, global, business and environmental responsibilities of the professional engineers, and the need for and principles of sustainable development."

In the same vein, McCullough (2006) stated some of the information literacy skills that engineers should acquire, according to the US engineering education accreditation body, ABET:

- *An ability to apply knowledge of mathematics, science, and engineering*
- *An ability to design and conduct experiments, as well as to analyze and interpret data*
- *An ability to design a system, component, or process to meet desired needs*
- *An ability to function on multi-disciplinary teams*
- *An ability to identify, formulate, and solve engineering problems*
- *An understanding of professional and ethical responsibility*
- *An ability to communicate effectively*
- *The broad education necessary to understand the impact of engineering solutions in a global and societal context*

- *A recognition of the need for, and an ability to engage in life -long learning*
- *A knowledge of contemporary issues*
- *An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Some of the ABET requirements, e.g., the requirement regarding lifelong learning, can be matched easily to similar information literacy standards. However, it is clear that every one of the ABET requirements is contingent (McCullough, 2006).

Indeed, it may be considered a problem that there are many different takes on ILS and a variety of "standards". We have, for example, the standards proposed by engineering accreditation bodies such as CEAB in Canada and ABET in the USA, and their overseas counterparts; the various national standards for ILS in higher education proposed by different national authorities (cf. the UK standards for British universities, at http://www.sconul.ca.uk/groups/information_literacy/headlines_skills.htm), and the standards proposed by library associations such as those of the American College and Research Libraries Association (ACRL[1]), or individual university library centres such as UC Berkely Centre for Science and Engineering Information Literacy (CSEIL). Moreover, these standards are evolving and subject to considerable debate. For example, the report of the five-year review of the information literacy standards for science and engineering in the US, compiled by the STS Information Literacy Standards Review Task Force (Berman et al, 2011) recommends rewriting the ACL standards. Then, there is the

[1] ARCL Information Literacy Standards, retrieved at http://www.ala.org/ala/acrl/acrlstandards/standards.pdf

issue of the relationship of these standards against emerging standards for skills related to life-long learning, which are likely best conceptualized as overlapping but not entirely congruent. There is thus much work to be done in terms of standardizing and analyzing ILS skills, and current research is also confounded by the circumstance that different definitions of ILS and different instruments to measure ILS abound. Not surprisingly, in most research extant, researchers create their own instruments. The fact that some ILS skills are difficult to measure, as well, means that there is not body of research that is based on actual performance-related outcomes.

An interesting contribution in this regard comes from Ross, Fosmire, Wertx & Cardell (2011) who report a study that comprises self-assessment of first year engineering undergraduate students against lifelong learning and ILS skills. The study was funded by Purdue's "Engineer 2020" seed grant program. The authors attempted to map ABET lifelong learning and ACRL info literacy standards for science and technology onto one another. They looked at the effects of their current initiatives for ILS and tried to correlate them with performance on authentic activities. In building their instruments, they modified and adopted concepts from engineering design process models and analysis of previous student work. They also based their instruments (which comprised some 60 Likert-scale items) on Kuhlthau's oft-cited (204) model of information search and retrieval behaviours.

While several publications cited in the Introduction point to the need for contextualization of ILS within specific disciplines or fields, there is a dearth of empirical investigations of what exactly ILS are in different fields, or how they differ. Sheila Weber (2005, 2008) is one of the few researchers who has investigated what ILS mean in different fields, by undertaking phenomonographic studies of academics in different fields, and their conceptions of ILS. She concludes that information sources differ, information behavior differs, information literacy differs, and people differ (along many dimensions including their institutional relations with, and views of librarians and information specialists and their roles in higher education). For example, for someone who teaches marketing, information sources include (Weber 2008):

• News Stories

• Journal & magazine articles

• Books

• Observation (e.g. observing how shoppers behave in a supermarket)

• Colleagues

• Business organizations - For someone who teaches marketing

• Statistical data

• Market research data

• Google

• Article databases e.g.

ABI/Inform

• Company websites

• Company accounts

• Librarians

While for a civil engineering professor, sources may be:

• Engineering journals

• Books

• Web of Science database

• Google

• Product information

• Manufacturers' websites

• Photographs

• Data sheets

• Design manuals

• Codes of practice

• Colleagues

• Land surveys

• Geographic Information

• Librarians

• Standards and Regulations

• Log books

Even when sources overlap, the use of information and related behaviors are, of course, different: "The Marketing professor needs today's news and articles to keep-up-to date with the business world: monitoring and searching are important." Whereas, "the Chemistry professor needs detailed, regular, up-to-date searches on specialist subjects"

Phenomenographic and observational studies of the application of ILS in professional practice or the workplace would also be of great value in informing the development and validation of meaningful standards.

Conclusion

There are many different definitions and frameworks concerning ILS in the literature. Nonetheless, the more influential view seems to be one that incorporates a number of features which are quite common across definitions – ILS as the ability to find, use, interpret, evaluate and apply suitable information, in an ethical fashion. Some definitions go further, and incorporate broad concepts such as problem-solving and communications skills. Others (mostly, but by no means exclusively, older references) limit ILS to the ability to use information technologies (technical skills or know-how) or define them as co-extensive with bibliographic skills in research. But these alternative definitions, either broader or narrower, are not at the center of ILS literature and research.

There is also some disagreement about whether ILS are completely generic, or whether they must be seen and understood within the specific contexts in which they are practiced in different disciplines. However, there are really no studies of how, for example, engineers actually use ILS, and which ones are more significant, in their work, research or studying.

In short, there are many claims concerning the importance of ILS, which hardly anyone debates, However, against this backdrop there are very few studies of how people perceive these skills, how they are developed, what are the best approaches to facilitate their development, how they can be integrated into higher education curricula, which skills different disciplines should emphasize, or how they are used in different contexts.

CHAPTER 3. METHODOLOGY

This research investigates the insufficient level of ILS within the graduate engineering students, as mentioned earlier. This chapter highlights the research questions, research design, the participants, the instruments, and the procedures employed in the study.

Research Questions

This research is exploratory in nature. Nonetheless, examining the literature review, considering anecdotal evidence, and analyzing the problem, lead to some guiding, rough, "hypotheses" that were addressed through the questions posed in surveys and focus group exercises, in an exploratory study. These questions or "hypotheses" are an initial set constructed based on a reading of the literature extant, and are not necessarily exhaustive. They represent a reasonable, reasoned starting point for investigating the dimensions and scope of the problem this dissertation addresses.

Hypotheses.

1. Professors lack deep comprehensive understanding of Information literacy
2. Professors lack the needed information literacy skills (or some of them)

3. Professors are not fully aware of the roles of other academic departments or services, such as educational technology and libraries, or faculty services for teaching development, within higher education settings.

4. Professors do not possess the skills to teach these information literacy skills.

5. All the results can be affected by gender, age, years of experiences and background.

6. Certain IL skills are needed for different engineering departments, before, during and after attending the classes.

7. Engineering professors do not ask the librarians' help to teach any IL skills.

8. The engineering students are not aware of the needed IL skills.

9. The engineering students do not know where to go to get these needed skills, in case they are aware of these skills.

10. Faculty and student perceptions of the importance of ILS and the extent to which they are addressed in programs may not coincide entirely.

11. There may be differences among students' perceptions depending on attributes such as seniority or professional work experience.

Research Design And Method

To answer the previous questions and to acquire a more nuanced picture of ILS in the context of engineering education, a pragmatic method is needed where both narrow and broad questions are brought to bear.

The case study approach is an intense study of individual research units or entities to seek deep understanding of all the related factors. Case studies can be constructed as "confirmatory" exercises, but more commonly, they are descriptive and, often, exploratory. Exploratory studies are intended to, e.g., understand the relationship among factors or variables, uncover basic dynamics associated with phenomena of interest, reveal important dimensions, potential causes, or descriptive variables. They serve as a basis to formulate hypotheses about underlying principles, create models, and pose hypotheses that may then be investigated using other research designs more appropriate to theory or model testing in a confirmatory mode. Exploratory approaches are appropriate, and necessary, when there is a lack of developed theory, confirmed principles, known causes or causality and further, perhaps, ambiguity or inconsistency concerning past observations and interpretations due in part to lack of sufficient data and a dearth of disciplined inquiry into the phenomenon (Creswell, 2007; Yin, 2009; Thomas, 2011). As argued in the introductory chapter, there is a lack of empirical studies concerning the underlying causes for poor levels of ILS skills in engineering students, as reported in surveys (mostly) of faculty perceptions. Given the critical importance of these skills as reflected in recent adjustments to engineering program objectives by regulating authorities, it is time to begin the process of unpacking the causes, and verifying the extent of the problem. Exploratory analyses are required at this early stage of inquiry.

Creswell (2008) highlights case study as one method to collect intensive or rich qualitative data, typically asking both broad and narrow questions and analyzing the data using themes extracted through an interpretive coding process. However, the data are then limited by the personal interpretation of the researcher. But Creswell (2007) also emphasizes that quantitative data reflecting close and narrow questions and using statistical analysis for larger samples, lacks the depth of the information that qualitative data provides. Thus a mixed method of collecting qualitative and quantitative data through using surveys that can be analyzed quantitatively and focus groups that provide rich qualitative data would be appropriate for this research. The qualitative data provides the research with deep understanding of opinions and behaviors, while the quantitative data can bring credibility, reliability, and a better opportunity for generalization and comparing results.

Schmidt (1997) highlights the advantages of the online survey (employed in this study) as an instrument that can reach large numbers of potential participants including large and diffuse or traditionally hard to reach populations, is cost effective, allows for faster data capture and analyses, and provides flexibility and convenience to respondents, which may help increase response rates. Feedback, as well, which can be automated through an online scheme for data collection, could be a form of interaction for participants that can increase motivation. On the other hand, Schmidt (1997) highlights the various potential problems where participants may not complete the questionnaires, or could provide unacceptable answers, or just subscribe more than one time, or where data may be considered, in some circumstances, less secure. Schmidt was writing in 1997, and, clearly, security around online data, possibly using commercial services “in the cloud”, is a subject that has seen many advances, including standards of encryption and password level protection on files and access. Additional problems can center on how to preserve anonymity where this is desirable or required, and how to constrain the sample to the population of interest. The latter is a concern if a “pass-along” approach is used to growing the number of respondents. It can be mitigated to some extent by including relevant demographic or other questions that help identify if respondents are in the appropriate category of interest in the study. This is more typically a problem in market research, while educational research may tend to start with a defined, target population for distribution of surveys. Of course, sampling bias, range, confidentiality of results and other issues are not peculiar to online surveys; they are issues for all research of this type. A variety of sources (e.g., Madge et al, 2006; Fang et al 2009; Crawford et al, 2011; Best & Krueger 2004) and contemporary methods textbooks in the social sciences provide guidance on how to use online surveys for research and avoid pitfalls, including elements such as guidelines or checklists for maximizing response rates, addressing sampling bias and satisfying ethical and security-related concerns. The approach of using online surveys is now ubiquitous in behavioral, educational social science research.

This study employed both online surveys and focus groups. Asbury (1995) highlights that focus group have been used early to “provide qualitative interpretation of quantitative data”. She further stresses that focus group is used in different settings including social sciences; business and marketing to seek deep understand of certain issues. She also highlights that focus groups could be used in conjunction with other research methods to enrich the data. In this study, focus groups, with semi-structured protocols, were used to provide additional information to complement the survey results, and to some extent, to provide cross validation of survey results. A semi-structured approach, based on selection of a set of broad thematic questions ensures that information collected across different focus groups can be compared and synthesized, and that the information complements the surveys. At the same time, without undue restrictions the participants have the ability to bring new themes to light, to subject hypothesis to discussion and possible counterargument, or to offer novel, potentially contesting interpretations. They are a powerful adjunct to survey methodology in an exploratory case study.

In summary, this research adapts a mixed method design, collecting both qualitative and quantitative data through a case study using online surveys and focus groups

Participants And Settings

The participants in this research are engineering professors and engineering students in two universities: Concordia University, located in Montreal, Canada and UOS, located in Sharjah, in the United Arab Emirates. The universities were chosen based on convenience, to some extent. The researcher was able to establish links with both institutions in a timely manner and this was critical to drive data collection. An alternative was to collect survey data more widely from a larger population, such as all accredited programs in Canada. It was deemed more difficult to drive a high rate of response in the latter approach, as compared with the procedure that was employed. Faculty at both UOS and Concordia were implicated in, and helped drive, the solicitation of responses. At the same time, it was also believed that for an exploratory study it might be preferable to collect data from a small number of institutions which can be described in some detail, rather than across a large number of institutions, whose own diversity might complicate the interpretation of results in an exploratory study.

At the same time, a number of criteria for selection as candidates for a case study were set out in advance. Concordia met the following criteria that were formed through investigating the literature, and examining the research questions or issues that emerged.

Additionally, there was a preference for including at least one Canadian institution with the goal of informing engineering education practice or policy in Canada. Specifically, Concordia meets the following criteria:

1.North American higher educational system (where the prominence of ILS in evolving curricular standards or objectives is particularly evident)

2. Comprehensive university that has several faculties including engineering, and the usual or typical range of ancillary support services or units (research libraries, teaching development centers, media services…)

3. Involved in accreditation procedures (CEAB is the association that recommends addressing ILS in the engineering programs)

4. Well-established university with good reputation

5. Easy access to collect data, through willingness of faculty to promote student surveys and participate in focus groups, as well as completing the online faculty survey, themselves).

Applying the same criteria to choose a university that represents a Middle East setting, which is a familiar culture to the researcher, we approached UOS. UOS is a comprehensive university. One of the largest in the country, it follows a North America education system model, is involved in accreditation and was accessible in terms of institutional and faculty cooperation. Founded in 1997, UOS has recently seen accreditation of three of its engineering programs by the American Board for engineering and technology (ABET).

Concordia University (www.encs.concordia.ca) was formed in 1974 through merging Loyola Collage (established: 1896) and Sir George Williams University (established 1926. The engineering department today is fully accredited by the Canadian Engineering Accreditation Board (CEAB).

These two universities (rather than a single institution) were chosen to ensure a sufficient amount of data for analyses of student and faculty surveys. It was not the intention to specifically carry out a cross-cultural study of ILS and engineering education. It was expected that data from the two sites would be similar (likely allowing of being analyzed as one group) given the commonalities of the programs, the requirements of the respective accrediting bodies (US and Canadian), and the ubiquity of the Internet, information tools, and challenges. At the same time, it should be noted that the existing literature is almost exclusively Western in terms of context and focus, so it is arguably a valuable contribution to provide data and analyses from another, in this case, Middle Eastern context.

Instruments

Researching the literature while examining all the definitions and characteristics of ILS, the questionnaires are formed to answer the different research questions. For example, to evaluate the needed skills in the engineering we adapt the working definition that includes all the skills that the different definitions mentioned in the literature. We also ask about the issues that we do not know such as: the needed skills before, during, and after the classes.

Research developed part for the questionnaires

Questionnaires on line. Online questionnaires were deployed to collect two kinds of data – both quantitative and qualitative - from engineering professors and engineering students in both universities (Concordia University and UOS). The two sets of online questionnaires were made available through the popular commercial survey management site, Survey Monkey. They include different kinds of questions: both open-ended questions where respondents can construct a short text to provide a potentially unique response, and closed-ended or fixed choice questions. The latter include multiple choice items (sometimes multi-select) and Likert scale items to capture various judgments or perceptions. The first set of 48 questions (appendix A) was available for the engineering professors and the second set of 25 questions (appendix C) was constructed for the engineering students.

Two rounds of data collection for students took place. The first one was carried out at the end of the winter 2012 semester, and the number of respondents was not satisfactory. The second round took place in the spring 2012. Before completing the survey, both students and professors were required to sign a consent form, as per a protocol approved by the research ethics committee at Concordia, and accepted by UOS (see appendices D, E).

Online questionnaires for engineering Professors: A few versions of the questionnaires were prepared as the instruments underwent several revisions cycles with feedback from different researchers (my supervisory committee).

The questionnaires have different sections (Appendices A, B, C) addressing: demographic information, teaching style or practices, ILS issues, and ILS in engineering. The teaching style section highlights the participants' policy and choices they make regarding teaching problems and approach; the ILS section seeks the opinions of the participants regarding ILS in general and the needed skills in engineering before, during and after the studying years, and after graduation. We used Likert scales (from 1 to 5) to ask the participants to evaluate the importance of different skills.

After obtaining the ethical approval of the research protocol to conduct research in Concordia University (according to North America rules), a special permission was also needed to collect data in any institute in UAE. Permission letters to be signed by the vice president for the academic affairs were requested and obtained.

Before running the final version of the questionnaires on the website, a pilot study was conducted to verify the questions' simplicity, easiness and clarity. An invitation email message was sent to the engineering professors at UOS (where the researcher was visiting at that time). The email addresses are available on the university web site. Four female and five male from different engineering departments, aged between 30 to 55 years old, responded and were scheduled for interviews individually in a meeting room in the engineering department, over a one-week period of time. Each interview lasted between 30 to 55 minutes. The questions then revised again and sent for another review with researchers (committee members). Some questions were rephrased for easier understanding, other questions restructured as a multi-choice question instead of an open-end one, some terminology were replaced with more familiar terms, and other questions transferred from multi-choices into open-end questions.

An invitation email message (available in the appendix H) was sent to all the engineering professors (in both universities) inviting them to participate in the study by completing the final questionnaires. The message explained the purpose of the research and noted that their email addresses are available on the university web sites.

One week later, a reminder message was emailed to the professors. In total, four reminder messages were been sent over a period of one month. These invitation messages (available in the appendix H) include a hyper link into the on-line page for the questionnaires. We chose to use the web link function in the Monkey Survey web site instead of the limited link function, so participants can access the link any time, anywhere. This function is used particularly when inviting a group of people, like students, without sending specific, individual emails.

The Survey Monkey platform (ww.sruveymonkey.com) is well-known and recognized among researchers and marketers as a practical, easy-to-use and secure place to host questionnaires. The questionnaires were available for professors after testing their functionality by two researchers. The setting did not allow researchers to trace the address of the participants, in order to keep them anonymous. Instead, we asked the participants to add at the beginning of the questionnaires their own unique code number that they could remember, and provide, in case they want to withdraw from the survey. This unique code comprises the first letter of their first name with the last four-digits of the home phone number. In addition, Professors could check their names out of the distribution list for any future communication regarding this research, in which case they would not receive any further reminding emails. The survey was available for four months.

The students' questionnaires: the students' questionnaires (available on Appendix-C) also went through several revisions based on feedback from different researchers (the committee members). The questionnaires contain demographic information, questions about ILS which ask the participants how they definite ILS, and what are the important skills they believe they need before, during and after their studies. Again, we used a Likert scale (from 1 to 5) to evaluate the importance of the different specific skills during their studies and after graduating. The questionnaires were ready at the same time as the Professors' questionnaires. Again, the students also were asked to add their own unique identifier numbers at he beginning of the survey to be used potentially to identify a particular set of questionnaires if the participants in question decide to withdraw from the study while preserving their anonymity.

The first round of data collection started at the end of the academic year. Email messages were sent to the students' representatives in the engineering faculty at Concordia University asking them to circulate the attached invitation message. The same letter reached the engineering Professors in both universities, asking them to circulate the invitation message among their students through the intranet they use. Four reminder messages in total sent to the four different engineering students' representatives in Concordia University, and to the engineering professors in both universities. The number of the participants of the students from both universities was not satisfactory, initially. It was the end of the academic year and students were not widely available. Another round of data collection took place during the spring semester where the engineering professors responded to the messages and forwarded the invitation to their students. In total we have 54 Concordia students and 79 of UOS respondents.

The data collected from the questionnaires are stored in the monkey survey sites with a password to which only the researcher has any access. A copy of this data is also stored on the researcher's laptop secured with a password, and password protected files, and a further copy of the files are stored in the cloud (Drop box) with a secure pass word known only to the researcher.

Focus groups. An invitation email message was sent to engineering professors in both universities asking them to participate in the focus group discussion. Five male Professors from Concordia University and four male professors from UOS responded to the message. The message includes choices of available dates for the discussion meeting.

The focus group discussion at Concordia University took place in a meeting room booked for this reason, in the sixth floor in the engineering Building at Concordia University. Dr. Steven Shaw facilitated this session and the researcher attended and participated through Skype, taking notes, and recording the session. The participants first read and signed the consent form (available in the appendix D). Dr. Shaw then introduced the research project and started the questions. After five minutes one Professor withdraw from the discussion owing to a previous commitment. Participants were answering the questions by turn, but they also did not hesitate to comment on their colleagues' inputs. The participants are not necessarily representative of the faculty profile overall, as they included one present chair and two previous chairs. As department chairs these participants have a specific role to play with respect to the integration of curricular objectives from the accrediting body into engineering programs and thus had a level of familiarity with, and interest in, the topic that presumably exceeds that of most faculty members. The session lasted for one hour and a half. Participants were very interested in the results of this research.

The four professors who responded to the invitation to participate in the focus group at UOS come from different engineering departments and have at least 15 years of teaching experience. The meeting took place in a meeting room booked for this purpose on the second floor in the engineering faculty at UOS in W9 building. The researcher welcomed the professors and distributed the consent forms. The researcher explained the research topic and the goal of the focus group discussion and started asking the questions. One Professor left early in the session, excusing himself without stating a reason for departing. The professors answered the questions by turn, then initiated a free discussion that extended the one hour scheduled event into an hour and a half. Participants were interested to follow up with the results of this research. The researcher was taking notes only since the participants indicated they did not want the session to be recorded.

Data Analysis

The online questionnaires. There are four groups available on the survey Monkey website: Professors in UOS, Professors in Concordia University, Students in UOS, and students in Concordia Universities. The results of the questionnaires are available and can be downloaded in the form of Excel spreadsheets. There are different kinds of questions:

- Yes/no questions, using the coding of 1 and 2 to count how many answer yes and how many answer no.
- Multiple choices questions where statistical analysis performed.

- Open-ended questions, where participants either express their opinions or e.g., list some skills
- Open-ended questions typically involved a list as responses. The responses were categorized and frequency counts for the categories were recorded.

Participants could, and did, skip answering questions. An alternative would have been to require an answer for each item before submitting the questionnaire. We did not use this approach, with the concern that it may have reduced response rates. For each item, in both student and faculty surveys, we report the percentage not answering (in some cases this is very high). The individuals not answering vary from question to question, but some simple analyses did not uncover any pattern in this non-response. Given the number of items that received no response, and the variability concerning who did not respond across items, it was not deemed feasible to drop out respondents with missing data from the analysis. It bears underlining the fact that the results have to be viewed in this light, even the descriptive account of results. The picture is clouded somewhat by the variability in the pattern of non-responsiveness across individual items.

For each item, in the results, the response frequencies are converted to percentages, given that the n for each item varies. Percentages do not always sum exactly to 100, owing to rounding to the nearest full percentage point. Given the nature of the data and the limitations of the study, reporting results to one or two decimal places would be to presume a level of precision that is not “real” or warranted.

Statistical analysis. The basic statistical analysis used in this study is the t-test (independent samples). This was used to determine if there were any differences between the two groups. If such tests revealed consistent differences, it would have been necessary to treat the two groups as separate cases, attempt to interpret or explain the origin of the differences, and address their practical significance in a cross-case analysis. In the absence of differences, we would be justified in collapsing the data and reporting it as constituting a single group.

In the end, there were almost no differences. However, in the report of results (which is descriptive), we do generally indicate the findings for both groups as there are subtle differences (these are less apparent when one collapses the two ends of the Likert scale (three rather than five points). Some of these differences can be explained, as addressed in the Discussion and Results chapters.

We used a five-point scale, allowing a neutral response, though some researchers favor a forced-choice scale. It seemed to us, intuitively, that respondents would have no opinion for some items. Many researchers employ a seven-point scale which potentially provides greater variability in the data (and precision), increasingly the likelihood of finding differences when they exist. In the present case, we felt we were dealing with concepts and issues that were not well understood, and judgments that were difficult to calibrate very precisely. In this context, a five-point scale seemed more appropriate – quite possibly a good deal of variability created through a seven-point scale would just amount to "noise", or error.

There are different philosophies concerning the analysis of Likert scale data. Basically, there are two schools of thought concerning whether Likert scales should be treated as ordinal or interval. On the one hand, some researchers believe that if there are a sufficient number of responses, that approximate closely a normal distribution, and if the intervals can be reasonably interpreted as commensurable, then scales can be treated as interval and ANOVA and other parametric analyses can be employed. The key assumption here is one of normalcy of the data (the distribution is key). At the limit, some even advocate the use of parametric analyses when this assumption is not well met and the sample is very small, but this is a very controversial position.

If a parametric approach like ANOVA is used to assess differences on group means for responses, then there are also several options for post hoc comparisons to isolate where the differences lie. Tukey (Sirkin, 2006) provides a middle-of-the-road option, while Fisher's LSD (Sirkin, 2006) is considered liberal, and the Bonferroni technique (which modifies the p-level based on the number of comparisons) is conservative.

On the other side, if one decides the data are to be considered ordinal level only, then non-parametric statistical analyses, which make no assumption about distributions, must be applied. Chi-square analysis is commonly chosen, using a simple comparison of two independent proportions with a z test. Normally, one would not report means (which have not the same meaning with ordinal data), but rather modes or medians, though it is not uncommon to report full descriptive with the results (means, medians, standard deviations etc.)

In this dissertation, I interpreted the scales as essentially interval, not merely ordinal. However, the violation of the assumption of normalcy is sufficient that we did not want to use techniques such as ANOVA or MANOVA. We chose to use t-tests, intended for small samples that are not necessarily normally distributed, to compare the results on from the two sites. A limitation of this approach is that we conducted multiple tests (independent samples t-tests), though one might expect these different results are not strictly themselves independent. In any event, with 20 separate tests conducted at the .05 level of significance, one would expect one test be significant just as a result of experimental error. If, for example, five tests are significant, this is encouraging, but one is statistically likely to be a result of error, and we have no way of knowing which one.

In the end, only a small number of about 20 tests were significant, and we can reasonably conclude that the samples were not “different” or from different populations. As mentioned earlier, we nevertheless chose to explain the results by incorporating, and pointing out, the differences across the two groups, even though they are not strictly statistically significant. This is appropriate (if somewhat painful) in a study that is fundamentally exploratory and descriptive in nature (more description being, on balance, better).

Regression analysis was also employed to detect any differences based on attributes of students other than institution (e.g., age, specialization, gender, experience). No significant variables were found.

The focus group. The basic procedures for organizing and conducting the focus groups are explained above. Recall that the Concordia focus group was recorded and the researcher took notes, while an experienced facilitator conducted the meeting. At UOS, the data was not recorded and the researcher took notes while also facilitating the session, a procedure that is not the ideal but that was necessitated by circumstances.

With the recorded material, a transcript was generated, then checked for accuracy, and two individuals (the researcher and an MA student in Education at Concordia) were employed to create a coding scheme, each working independently.

The script was analyzed, coded, labeled into headings and subjects, while considering the “research questions” or issues addressed in the protocol. The headings and subjects were adapted by the two researchers who organized the text into tables. The two researchers compared results of the exercise and generated by consensus a final table of results.

Verifying Data Accuracy

Several steps were taken to verify the accuracy of data for the quantitative analyses (t-tests):

- Double check when transferring the survey data into the excel sheets

- When labeling and categorizing the data, the researcher follows the same step of comparing the data between the many sources.

Limitations of Methodology

Limitations of the study can come from design, data, sampling strategies, and analytical procedures. “Limitations” are also relative to the expressed aims of the research. In the present case, we had a limited number of respondents to the surveys (a total of about 80 faculty, and 150 students), and we did not have large numbers of representatives across the different specializations. This is still within the range considered normal for response rates to unsolicited surveys. We do not know the profile of the student population or faculty population at the two universities, so we cannot really say how representative our samples are. Thus, generalization is compromised, but bear in mind this study was conceived as an exploratory case study, so maximizing generalization was not a central goal.

Ethical Issues

For the focus group: participants sign a consent form explaining that they agree to participate. The identity of the participants is kept known only for the researcher.

For the survey: the participants are anonymous and the answers do not give any information about the participant. The survey is designed in such a way as to hide the ip address of the participant to keep the identity safe. However, participants are allowed to withdraw from the survey anytime so, to enable this possibility, we created a unique code system for every participant. Each participant can create his or her unique code from combining the first letter of the first name plus the four-digit home phone number. This code appears on each survey, and participants are unlikely to forget either component of the code.

The data was kept in a file on the laptop of the researcher and secured with a password. A back up copy was kept on Dropbox for which only the research and the supervisor have the password.

CHAPTER FOUR: ANALYSIS AND RESULTS

Data Sources

As mentioned earlier, this research employed questionnaires administered online (Appendix A, C) to seek the opinions of engineering professors and engineering students in two universities, Concordia University (in Montreal, Canada), and UOS (in Sharjah, UAE), regarding the nature, importance, level and modes of instruction for ILS in engineering. In addition, two focus groups (Appendix B) were conducted with engineering professors at Concordia and UOS, to acquire a deeper understanding of issues related to ILS and their instruction.

Analytic Strategies

Data collection and analytical strategies are presented in the methods chapter. Recall that online questionnaires, both for professors and students, include open- and close-ended questions, including items constructed with a five-point Likert scale. The open-end questions, which allow participants to express their opinions freely, were coded and organized into headings and subjects, which were then transferred into tables and charts. Statistical analyses were used to summarize and evaluate the quantitative data: basic descriptive statistics summarize the findings, while t-tests were employed to identify any significant differences between groups, defined in terms of location

(Concordia versus UOS) or based on other descriptive variables such as age, experience, or specialization.

The focus group data was organized into various headings and themes. Two researchers coded and formed the subjects and headings, with the coding schemes subjects to analysis for inter-rater reliability. However, the focus groups data provide the opinions of the participants and in most cases, the data is used as it is (without coding) in this chapter.

Statistical analysis. We first ran a series of statistical tests to ascertain whether there were differences between the groups at Concordia and at UOS. If no differences were found, it would be possible to collapse the two groups into one for the purposes of summarizing results. As explained in the Methodology chapter, there are several options and philosophies regarding how to analyze the relevant data which, in this case, constitute mostly Likert-scale items on a five-point scale. We chose to use t-tests, as explained. The results showed no significant differences except on one comparison. Appendix F provides the results of tests comparing the importance of different components of ILS and engineering-related skills and knowledge as perceived by Concordia versus UOS professors. Of 16 independent samples t-test only one was significant, and it was not directly related to ILS: Concordia professors rated knowledge of professional standards as more important that UOS professors. Given that tests were performed at the .05 level, we would expect that one of these tests would be significant as a result of experiment-wise error. Overall, the statistical analyses support the conclusion that the groups are not different (they are from the same population). However, in reporting the results we will generally explain the differences between the two groups, given the descriptive and exploratory nature of the study. Some of the differences are easy to explain in terms of factors such as the linguistic context, and differences in the educational systems that prepare students for university education, in the two locations.

The Study Participants

The participants are engineering professors from Concordia University and UOS, as well as engineering students studying in both universities. The total number of Professors in UOS is 42 and 17 responded to this survey. The response rate was much lower from Concordia, where 17 of the 144 engineering faculty contacted responded.

Five professors from Concordia participated in the focus group, compared with four professors from UOS. One Professor from Concordia left the focus group meeting due to a commitment to another meeting. All the five Concordia professors who participated in the focus group have a minimum of 20 years of teaching experience in the HE settings, and all of the participants are male. Three of them come from the civil department and two are from the mechanical department. The professors from the UOS come from different engineering departments within both civil and mechanical engineering. The participants have at least 15 years of teaching experience in HE, and all of them are males. Similarly, one Professor from UOS chose to leave the focus group meeting after five minutes, feeling uncomfortable answering questions about ILS, although the researcher assured the anonymous of the answers.

Meanwhile, the engineering students who participated are males and females studying at different level (grads and undergrads) and in different engineering departments in Concordia University and in UOS.

It should be reiterated that throughout the results section, for each survey questions the missing data (that are more than 12%) are noted since the percentage of the participants who answered questions differs from one question into another.

The Results

Since this chapter presents the findings of the questionnaires and the focus groups ,supported by the statistic analysis, as mentioned above, the results are organized in two sections: engineering professors and engineering students.

Engineering Professors. In order to understand the ILS issues in engineering, we sought the opinions of the engineering professors on different issues: understanding the roles of other departments in the university, librarians' role, the nature and significance of ILS in engineering, their understanding of how ILS are acquired or developed, and the professors' educational experience.

Demographic Information. Only 17 professors from each university completed the questionnaires. Participants come from different engineering departments and belong to different age groups. Eighty eight percent of the professors responding are males. See the tables 1, 2 below, for details.

Table 1 - Profs - age

Age	UOS	Concordia
Within 50s	59%	41%
Within 40s	35%	23%
Within 30s	6%	12%
Within 60s	0	23%

Table 2 - Profs - departments

Department	UOS Professors	Concordia
Civil department	35%	53%
Architecture department.	23%	6%
Electrical department	18%	18%
Computer	6%	12%
Industrial	18%	6%
Sustained energy/others	6%	6%

Twenty-three percent of UOS professors compared with 46% of Concordia professors received research skills training, related to the scope of our definition of ILS, and 41% of UOS professors compared with 46% of Concordia professors received teaching skills training.

Thus, this is a somewhat diverse group in terms of age, specialty, gender, and ILS related training, as might be expected.

Are professors aware of other university departments' services? As mentioned in the literature review chapter, librarians have claimed a certain stake in regard to the responsibility for teaching the IL skills, primarily through the modus of running generic workshops for students. In the literature there are also claims that some professors may, for example, be reticent to allocate class time for ILS skills training delivered by library staff. We asked the participants to clarify:

First we asked them where they believe engineering faculty should go when facing problems with: embedding technology in teaching, teaching, or information usage. We provided seven choices to choose from: education department, library, colleagues, web, I know the solution, certain services, and all the above. More UOS professors (47%) than Concordia professors (31%) would seek the help of their colleagues when facing a problem of embedding technology in teaching. Also, 47% of UOS professors, compared to 19% of Concordia professors, would consult certain services within the university (see figure below for a detailed break-down of responses).

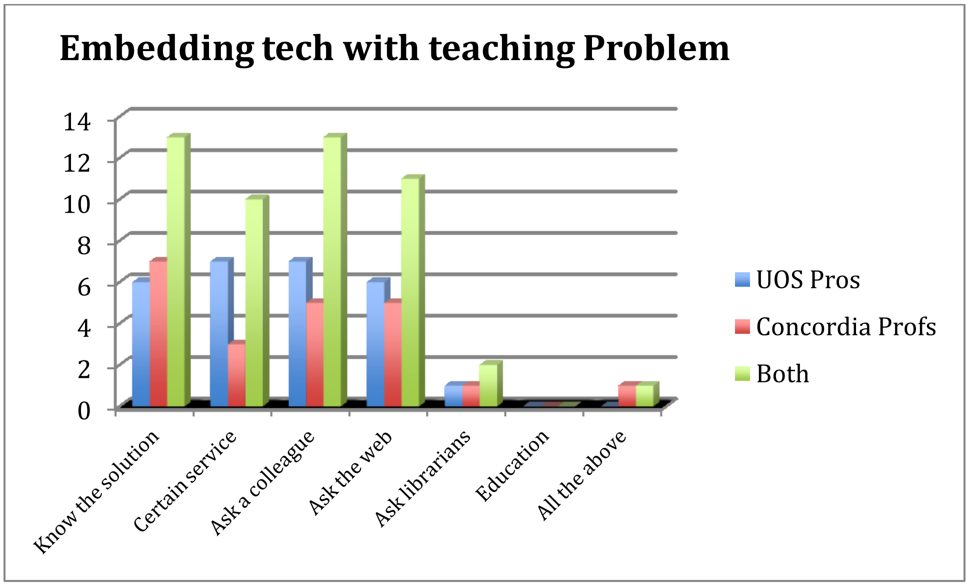


Figure 1 - professors - solving problems of embedding tech with teaching

But, when engineering professors face a teaching problem, the majority of professors in both universities (UOS: 60%, CON: 69%) would ask a colleague for assistance (the figure 2 details the results).

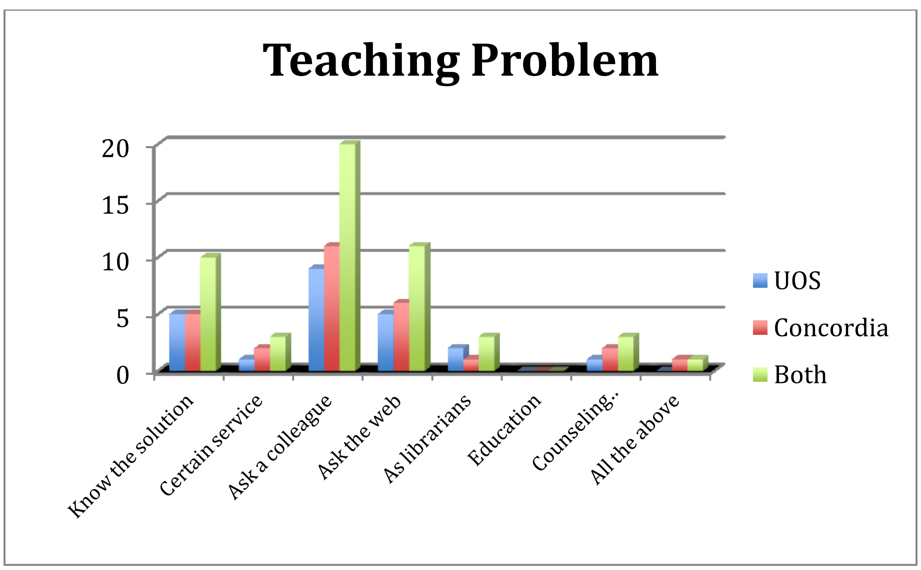


Figure 2 - Profs - solving teaching problems

Again, there is a seemingly large difference between Concordia professors (69%) as compared with UOS (33%) professors concerning what to do when facing an information usage problem. Sixty-nine percent of Concordia faculty respondents would ask a colleague when facing an information usage problem compared with only 33% of OAS professors. More UOS professors (40%) than Concordia professors (31%) would consult the web, as Figure 3 explains.

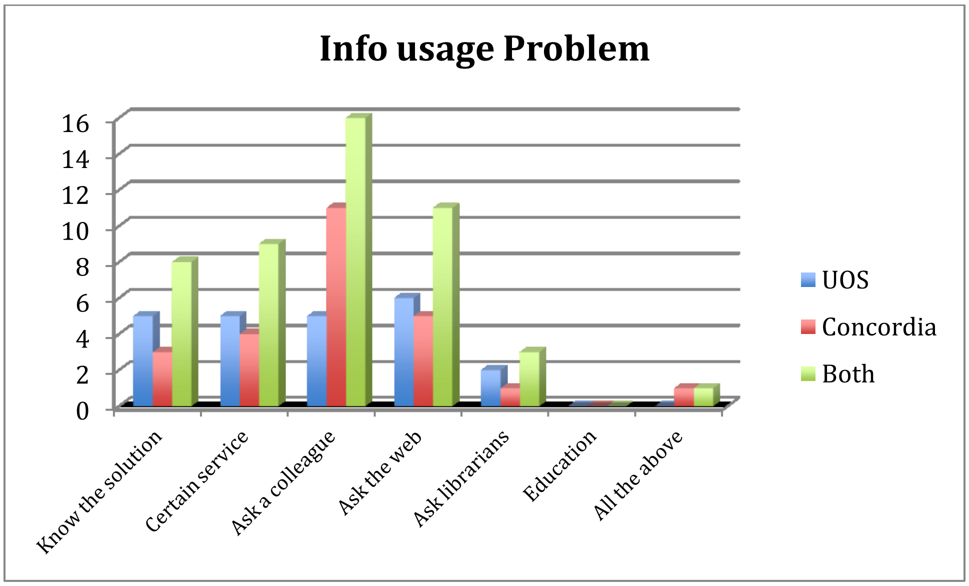


Figure 3 - Profs - solving Info usage problems

However, no professors would ask the help of an education department and only a very few professors would consult a librarian (6%) when professors from either university would face any problem with embedding technology into teaching or with regard to teaching or information usage.

Second, we asked the participants about their policy towards inviting guest speakers or experts to their classes. Eighteen percent of UOS professors compared to 35% of Concordia professors did not respond to this item, but the remaining professors from both universities indicated they invite guest speakers, but from outside the university. Few professors from either university (UOS: 36%, Con: 27%) would invite speakers from inside the university. A few Concordia professors further explained that they prefer to invite guest speakers to talk about: “engineering management”, “legal issues” and “standards”, or just “professional” speakers “from the industry”. But 28% of UOS professors chose guest speakers that talk about engineering topics as the table below explains.

In summary, the majority of professors from both universities would invites guest speakers for their classes; however, they prefer to invite guest speakers from outside the university (from the industry) to talk about engineering topics. Nonetheless, as the table below reveals, a variety of topics are covered in this manner that are related to ILS: specifically, communication, ethics and writing.

Third, we asked the participants: have you been approached from different departments or services within the university to hold a workshop in your class? Eighteen percent of UOS professors, compared to 6% of Concordia professors, skipped answering this question. But 93% of the UOS professors who responded declared that they had not been approached from a different department or services within the university to hold a workshop in their classes or to talk to the students during the classes. In the same vain, 81% of Concordia professors also declared that they had not been approached by any departments in the university to hold a workshop or to talk to the students in the class. Only 19% of Concordia professors declared that they have been approached by departments such as: a center for teaching and learning services and for software measurements. However, Concordia professors in the focus group mentioned that there is a subject specialist in the library, and librarians are always welcome to hold a workshop in the engineering department outside of class time. Furthermore, Concordia library staff regularly offer workshops for engineering students who can register for these events on their own.

In addition, the majority of engineering professors either seek the help of their colleagues when they face a teaching problem, or an issue concerning information usage in teaching (for Concordia professors), or embedding technology in teaching. The majority of professors also believe they would know how to solve the problem themselves or would seek assistance from another department or service within the university when they have a problem of embedding technology in teaching.

In addition, the majority of the professors would invite guess speakers from outside the university (from industries) to speak about engineering topics. And the majority of professors claimed that they have not been approached from any department in the university to hold a workshop in their classes.

These results show that professors in both universities are either not aware of the roles of other departments in the universities, or discount the notion there are external resources who could assist in the areas mentioned. Lack of awareness may well be the issue, given the claim that they have not been approached from any department within the university to hold workshops in their classes. Very few faculties would ask the help of librarians and the surveys indicate the participants would never seek the help of educational departments. When they would like to invite a guest speaker they clearly prefer to invite engineers from the industry, outside the university, to talk about engineering topics. However, the Concordia professors in the focus group talked about the workshops that the library hold for engineering students and librarians are always welcome to hold optional workshops in the department (according to a previous engineering chair).

Do engineering professors ask the help of librarians in teaching ILS?

Investigating the relationship and the negative attitudes of the engineering professors towards librarians, as mentioned earlier, we asked the participants two questions regarding this matter.

First we ask the participants' opinions about the role of librarians in general. Thirty-five percent of professors in both universities did not explain their opinions about the librarians' roles in general. But the majority of professors (UOS: 82%, Con: 64%) believe that librarians' role is to help students to get the information and resources they need in the library. In addition one UOS professor claimed that there is no role at all for a librarian at the university level. The following tables 3 and 4 have more details:

Table 3 – UOS Profs - Role of librarians

What is the role of librarians	UOS Professors
Help students to get the info they need	82%
No role in the university	9%
Facilitate ILS	9%

Table 4 - Con Profs - Roles of librarians

What is the role of librarians	Concordia Professors
Important	18%
Help students in the library to find information	64%
To facilitate access to knowledge	9%
Help students in research	9%

Second, we asked the participants about librarians' roles in their classes. Forty-one percent of professors in both universities did not answer. But 70% of UOS professors, compared to 50% of Concordia professors, believe there is no role for a librarian in their classes.

In the same vain, UOS professors responding through the focus groups stress that there is no role for a librarian in their classes. They were surprised to be asked such a question. But one professor from Concordia University highlights, through the focus group, the important role a librarian plays in students' studying through guiding them to the needed resources while they have projects or assignments to do.

To summarize, engineering professors believe the only role Liberians can play is to helps students find materials related to resources in the library that help them in their research or midterm papers. But engineering professors are firm about the conclusion that there is no role for librarians in their classes.

Conclusion. As mentioned in the literature review chapter, librarians have staked a claim in the library and information sciences literature, at least, regarding their role and responsibility regarding instruction and instructional resources for ILS, and they have also registered that sciences and engineering professors have a negative attitude towards them. The above study results show that engineering professors believe the librarians' only role is to serve students, in the library, by identifying or recommending materials and books to help them do their assignments. They do not appear to accept that class time should be allocated for activities related to ILS, delivered by external resources. These results confirm previous research findings concerning engineering, ILS and the participation of librarians in the development of ILS in engineering students.

The most important IL skills in the engineering discipline. To understand what is the conception of ILS prevalent among engineering faculty and their perceptions regarding what are the ILS needed in the engineering department, we asked the participants a few questions:

First, we asked the participants about the skills that they expect students to have when they walk into classes. Thirty-six percent of professors from both universities assume that students would have communication skills while starting their classes. Another 36% of Concordia professors assume students would have the prerequisite skills that each class requires. Meanwhile, 28% of UOS professors assume students would have computer and software skills, English language including writing skills, and information searching skills when starting their classes. However, the table (5) below presents the details:

Table 5 - Profs - Skills to start classes

Skills needed to enter class	UOS Professors	Concordia Professors
Communication skills	36%	36%
Note taking/listening	14%	0
Technical writing	14%	21%
Programming	7%	0
Laboratory safety / equipment handling	7%	0
Excel, PowerPoint, computer skills	28%	14%
Math	14%	0
English/writing	28%	0
Sketching and technical drawing	7%	7%
IT	7%	0
Analytical	7%	14%
Info search/research	28%	7%
Presentation	0	21%

Prerequisites	0	36%
Methodology and research	0	14%
Teamwork	0	7%
Concentrating/thinking out of the box	0	7%
Problem solving	0	7%

Clearly there are many similarities but, in this small sample, Concordia professors have a higher expectation that students entering the programs will have prerequisite knowledge and skills, while UOS faculty appear to have higher expectations of their students' information retrieval skills. UOS professors more often expressed the belief that entering students would have appropriate English language (language of instruction) skills. These differences are likely a reflection of the different linguistic contexts, university policies (regarding, e.g., language proficiency, academic admittance criteria), and educational context (the nature and quality of the systems that prepare students for university).

Within the focus groups UOS professors emphasized that students come to the classes and lack the basic, relevant prerequisite skills and knowledge that are required. They further explained that although students come having completed prerequisite courses, they still do not have the needed skills and this is due, in their opinion, to the students' lack of responsibility. Students, according to them, just want to graduate and finish the university without paying close attention to the needed skills. One professor mentioned in the focus group that he has to go through a review of all the necessary older or prerequisite materials so students would be able to consume new materials.

In summary, the majority of UOS professors expect students to have communication skills, information searching skills, or computer and software usage skills when they start their classes. Meanwhile, the majority of Concordia professors expect students to have the prerequisite knowledge and skills that are related to the class, and communication skills. Communication skills were equally important in the perceptions of both groups; however, the possession of presentation skills was registered as an expectation of students for Concordia faculty, but not by UOS faculty

Second, we asked the participants which skills they expect students to have when they finish their classes. The majority of the professors (UOS: 64%, Concordia: 50%) would like students to gain the course related skills and knowledge when finishing their classes. But more Concordia professors (44%) than UOS professors (14%) would like students to gain improved communication skills when they finish their classes. In the same vein, the Concordia professors who participated in the focus group discussion emphasize the fact that they want their students to gain ILS such as communication skills, including presentation skills, when they finish their classes. However, Concordia professors explained further (in the focus group) that they do not exactly teach these skills but rather only provide feedback to the students and expect students to "pick up these skills" incidentally throughout the course. They further explain that they do not know how to teach these skills but that they are part of the course outcome. The table 6, and figure 4 below detail the responses of the professors for the questionnaires.

Table 6 - Profs - Skills when finishing classes

Skills when finishing class	UOS Professors	Concordia Professors
Problem solving	28%	25%
Analytical skills	14%	0
Experimental skills	7%	0
Course related skills	64%	50%
How to get info	14%	0
Critical thinking	21%	19%
IL/other soft skills	7%	6%
Communication	14%	44%
Use the taught materials in real life situation	0	6%
Team working, leadership	7%	19%

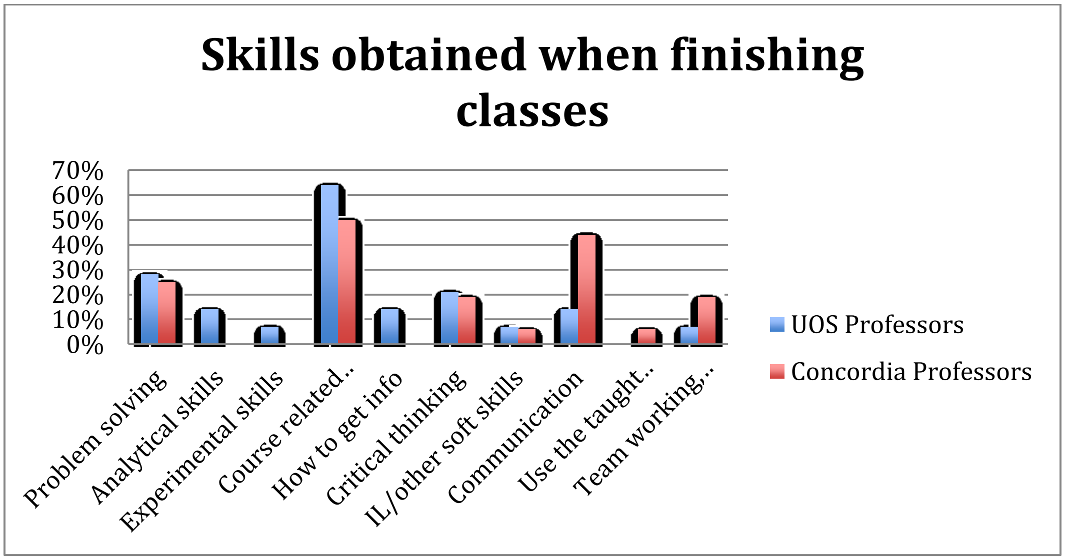


Figure 4 - Profs - skills when finishing classes

On the other hand, Concordia professors highlighted through the focus group that they want students to gain the “sub skills” through the courses. These skills are one of the outcomes of the course. But professors further stress that they do not really teach these skills, they only expect students to pick up these skills through project work, supervisor’s feedback, or through peer work.

As one professor explains: "We try to give them some examples of cases and we expect them to catch on how to analyze them". Another Professor adds: "But the direction to what this is coming to not at the end of the courses we tell you but at the very beginning of the course we tell the students, here you learn critical thinking, this is the target, but are we going there, how we are going there still is not clear."

To summarize: the skills that professors would like students to have when they finish their classes revolve mostly about the course related materials, and a mix of skills such as: Problem solving, Team working, Communication skills, and Critical thinking.

But according to Concordia professors, they do not really teach these skills although they could be part of the outcomes. They just expect students to pick up these skills via feedback, setting of expectations, and incidentally. Both OAS and Concordia faculty expected improvements in problem-solving (25% and 28% of respondents, respectively). Teamwork and leadership figured more prominently in Concordia responses. Fourteen percent of OAS respondents versus no Concordia respondent expected improvements in analytical skills. Recall that a small percentage of Concordia faculty (as opposed to no OAS respondents) expected students to arrive with analytical skills. It is difficult to interpret this particular finding, and its relation to problem-solving as an outcome (conceptually, the two seem related, but this is not reflected in results) without further detailed insight into the respondents' understanding of the terms "analytical skills" and "problem-solving skills".

Third, we ask the participants about the skills that students should have when they ultimately graduate from the engineering program. Twenty-nine percent of professors from both universities did not answer this question, but the majority of UOS professors (75%), compared to only 8% of Concordia professors believe students should graduate with problem-solving skills. Also 58% of UOS professors only believe students should graduate with engineering related skills. There are few skills that only Concordia professors believe students should graduate with such as: professionalism and technical skills (25%), presentation, writing, research and life-long learning skills (8%). In the same vain, a few UOS professors only believe students should gain skills when graduating such as: critical, logical and analytical thinking skills, and using engineering in communities. The table (7) below provides details:

Table 7 - Profs - Skills when graduating

Skills when graduating	UOS Professors	Concordia Professors
Problem solving	75%	8%
Engineering related issues	58%	0
Use engineering in communities	8%	0
Communication skills	33%	17%
Critical / analytical thinking	16%	0
Logical thinking	8%	0
Leadership, ethics, etc.	16%	17%
Searching for info	8%	8%
Teamwork	8%	8%
Presentation skills	0	8%
Management	0	17%
Technical skills	0	25%
Professionalism	0	25%
Writing skills	0	8%
Research skills	0	8%
Life-long learning skills	0	8%

However, Concordia professors in the focus group highlighted that students need to obtain important workplace skills, such as communication skills, when finishing their program: "that employers want and really require seeing that our graduates have much better communication skills."

To summarize, the majority of UOS professors believe engineering related knowledge and problem solving skills are the skills that students should acquire on graduating from the engineering program. But UOS professors also mention a variety of other skills, such as: analytical, logical and critical thinking skills, and using engineering in community services.

Meanwhile, Concordia professors also identified a few skills that they want students to obtain by the time they graduate, such as: writing skills, life-long learning skills, research skills, professionalism, technical skills, presentation skills, and management skills. The strong emphasis on “professionalism” (25% of respondents) seems noteworthy, and accords with the comments on workplace or employability skills presented in the focus group.

The following figures 5 explain the skills that students need to have when graduating from the engineering program as professors from both universities believe.

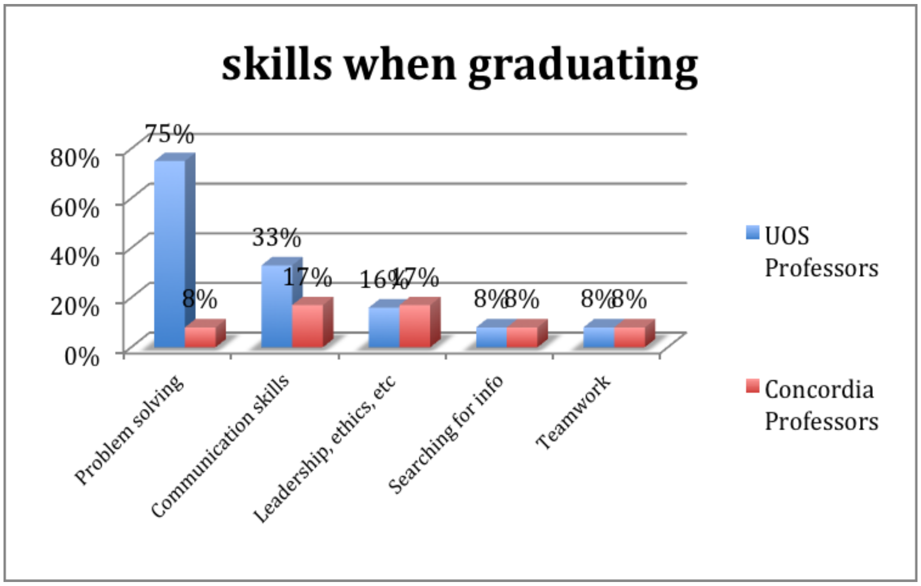


Figure 5 - Profs - Skills when graduating

The fourth question posed is about precisely which ILS are needed to ensure students' success. As mentioned earlier, various authors highlight the fact that engineering needs specific ILS skills, but the gap is that there is no mention about these skills. What are these particular skills? Are they general or very specific? In order to solve the main problem that this research tries to address, we need to know what are the most important ILS that are needed in the field, and study, of engineering to make sure students have these skills when they graduate. Therefore, using the concept of ILS that was adopted for this research, we asked the participants how important are the component skills to the engineering students' success. We used a five-point Likert scale where participants would rank the different named skills in terms of their importance for their students' success, as follows:

5 = the most important.

4 = important

3 = neutral

2 = not that important

1 = the least important

Seventeen percent of UOS professors and 12% of Concordia professors did not answer this question, but the answers provided by the remaining participants are presented below, organized in two tables: a detailed table according to the previous scale and a “collapsed response table” where we collapse the "very important" and "important" into "important", and the "not that important" and "not important" into "not important".

Ability to access information. The majority of the professors from both universities (80%) believe the ability to access information is important to the students’ success. But proportionately more Concordia professors (60%) than UOS professors (43%) believe these skills are very important. However, a t-test shows that there is no difference between the two groups. As the tables (8 & 9) below indicate, collapsing the two sides of the Likert scale leaves us with very similar results.

Table 8 - Profs – Ability to access info skills

Ability to access info	UOS Professors	Concordia Professors
Very important	43%	60%
Important	36%	20%
Neutral	21%	7%
Not that important	0	13%
Not important	0	0

Table 9 - Profs - ability to access info skills (comp)

Ability to access info	UOS Professors	Concordia Professors
Important	79%	80%
Neutral	21%	7%
Not important	0	13%

Research skills. More than half of the respondents from both universities (UOS: 57%, Concordia: 60%) believe that research skills are important for students' success, where more Concordia Professors (27%) than UOS Professors (7%) believe these skills are very important. But no UOS Professors believe these skills are not important comparing to 13% of Concordia Professors who believe these skills are not that important. The tables (10 & 11) below explain:

Table 10 - Profs - Research skills

Research skills	UOS Professors	Concordia Professors
Very Important	7%	27%
Important	50%	33%
Neutral	43%	27%
Not that important	0	13%
Not important	0	0

Table 11 - Profs - Research skills (comp)

Research skills	UOS Professors	Concordia Professors
Important	57%	60%
Neutral	43%	27%
Not important	0	13%

Knowledge of Computer skills. the majority of the professors in both universities believe that knowledge of computer and software is an important skill for the students' success, but more Concordia Professors (47%) than UOS professors (21%) believe this skill is a very important one. However, no UOS professors believe these skills are not important, compared with 14% of Concordia Professors. Table 12 & 13 detailed.

Table 12 - Profs - Knowledge of computers skills

Knowledge of computers	UOS Professors	Concordia Professors
Very strong	21%	47%
Strong	64%	27%
Neutral	14%	13%
Not that important	0	7%
Not important	0	7%

Table 13 - Profs - knowledge of computers (comp)

Knowledge of computers	UOS Professors	Concordia Professors
Important	85%	74%
Neutral	14%	13%
Not important	0	14%

Writing Skills. The majority of the professors from both universities (UOS: 64%, Concordia: 73%) believe writing skills are important for students' success. But more Concordia professors (40%) than UOS professors (21%) believe these skills are very important. However, no UOS professors believe these skills are not important compared to 13% of Concordia professors who believe these skills are not that important. The following tables (14, 15) explain:

Table 14 - Profs - Writing skills

Writing skills	UOS Professors	Concordia Professors
Very important	21%	40%
Important	43%	33%
Neutral	21%	13%
Not that important	0	13%
Not important	0	0

Table 15 - Profs - Writing skills (comp)

Writing skills	UOS Professors	Concordia Professors
Important	64%	73%
Neutral	21%	13%
Not important	0	13%

Library skills. More Concordia professors (60%) than UOS professors (39%) believe library skills are important to the students' success. However, more UOS Professors (38%) than Concordia Professors (14%) believe these skills are not important. The following tables (16, 17) detail:

Table 16 - Profs - Library skills

Library skills	UOS Professors	Concordia Professors
Very important	8%	27%
Important	31%	33%
Neutral	23%	27%
Not that important	23%	7%
Not important	15%	7%

Table 17 - Profs - Library skills (comp)

Library skills	UOS Professors	Concordia Professors
Important	39%	60%
Neutral	23%	27%
Not important	38%	14%

Visual skills. The majority of the professors in both universities (73%) believe visual skills are important for students' success. Further, no professors from either university believe these skills are not important. The following tables (18, 19) present more details:

Table 18 - Profs - Visualization skills

Visual skills	UOS Professors	Concordia Professors
Very important	36%	13%
Important	36%	60%
Neutral	29%	27%
Not that important	0	0
Not important	0	0

Table 19 - Profs - Visualization skills (comp)

Visual skills	UOS Professors	Concordia Professors
Important	72%	73%
Neutral	29%	27%
Not important	0	0

Communication skills. Although the majority of the professors in both universities believe communication skills are important for students' success, more Concordia professors (94%) than UOS professors believe these skills are important. The statistical analysis also highlights this difference, as this is one of the few comparisons where the associated t-test was significant. However, only 14% of UOS professors believe communication skills are not important for students' success. The following tables (20, 21) explain:

Table 20 - Profs - communication skills

Communication skills	UOS Professors	Concordia Professors
Very important	36%	47%
Important	29%	47%
Neutral	21%	7%
Not that important	7%	0
Not important	7%	0

Table 21 - Profs - Communication skills (comp)

Communication skills	UOS Professors	Concordia Professors
Important	65%	94%
Neutral	21%	7%
Not important	14%	0

Networking skills. The majority of the professors from both universities believe networking skills are important for students' uses where more of Concordia professors (53%) than UOS professors (21%) believe these skills are very important, but only 7% of UOS Professors believe that these skills are not that important. The following tables (22, 23) provide more details:

Table 22 - Profs - Networking skills

Networking skills	UOS Professors	Concordia Professors
Very important	21%	53%
Important	50%	20%
Neutral	21%	26%
Not that important	7%	0
Not important	0	0

Table 23 - Profs - Networking skills (comp)

Networking skills	UOS Professors	Concordia Professors
Important	72%	73%
Neutral	21%	26%
Not important	7%	0

Problem solving skills. All the professors in both universities agree that problem-solving skills are important to the students' success but more Concordia professors (93%) than UOS Professors (64%) believe these skills are very important. See tables 24, 25 below:

Table 24 - Profs - problem solving skills

Problem solving skills	UOS Professors	Concordia Professors
Very strong	64%	93%
Strong	36%	7%
Neutral	0	0
Not that important	0	0
Not important	0	0

Table 25 - Profs - Problem solving skills (comp)

Problem solving skills	UOS Professors	Concordia Professors
Important	100%	100%
Neutral	0	0
Not important	0	0

Critical thinking. All the professors in both universities believe that critical thinking skills are important to the students' success, but more Concordia professors (80%) than UOS students (64%) believe that these skills are every important. The tables below (26, 27) provide further details:

Table 26 - Profs - Critical thinking skills

Critical thinking	UOS Professors	Concordia Professors
Very important	64%	80%
Important	36%	20%
Neutral	0	0
Not that important	0	0
Not important	0	0

Table 27- profs - Critical thinking skills (comp)

Critical thinking skills	UOS Professors	Concordia Professors
Important	100%	100%
Neutral	0	0
Not important	0	0

Decision making skills. The majority of the Professors in both universities (UOS: 93%, Con: 80%) believe that decision-making skills are important for the students' success in engineering, where more of Concordia professors (67%) than UOS professors (50%) believe these skills are very important. Only 7% of UOS professors believe these skills are not that important. The following tables (28, 29) provide more details:

Table 28 - Profs - Decision making skills

Decision making skills	UOS Professors	Concordia Professors
Very important	50%	67%
Important	43%	13%
Neutral	0	20%
Not that important	7%	0
Not important	0	0

Table 29 - Profs - decision making skills (comp)

Decision making skills	UOS Professors	Concordia Professors
important	93%	80%
Neutral	0	20%
Not important	7%	0

Professional standards skills. Although the majority of professors from both universities agree that professional standards skills are important to the students' success, more Concordia professors (93%) than UOS professors (43%) believe these skills are very important. Meanwhile, none of the professors believe that these skills are not important for the students' success. The following tables explain (30, 31).

Table 30 - Profs - Professional standards skills

Professional standards	UOS Professors	Concordia Professors
Very important	43%	93%
Important	43%	0
Neutral	14%	7%
Not that important	0	0
Not important	0	0

Table 31 - Profs - professional standards (comp)

Professional standards	UOS Professors	Concordia Professors
Important	86%	93%
Neutral	14%	7%
Not important	0	0

Ethics skills.. All the Professors from both universities believe that ethics skills are important for students' success. However, Concordia professors (94%) believe more strongly than UOS professors (64%) that these skills are very important. The following tables (32, 33) further explain:

Table 32 - Profs - Ethics skills

Ethics skills	UOS Professors	Concordia Professors
Very important	64%	94%
Important	36%	6%
Neutral	0	0
Not that important	0	0
Not important	0	0

Table 33 - Profs - Ethics skills (comp)

Ethics skills	UOS Professors	Concordia Professors
Important	100%	100%
Neutral	0	0
Not important	0	0

To summarize, all professors believe the following skills are important for students' success:

- Ethics
- Problem-solving
- Critical thinking

Meanwhile, it is only regarding the perception of the importance of communication skills that we find a statistically significant difference, with Concordia professors emphasizing these skills to a greater extent than their UOS counterparts. This finding is reinforced by the fact that the Concordia professors also highlighted the importance of these communications skills for any engineer, during the focus group exercise

The fifth question is about ILS in engineering: if they are generalizable or discipline-specific? In order to have a full and clear understanding of ILS in engineering education, we need to know what kind of ILS are critical in engineering, or how they are used specifically in the field? Are they generic or discipline (even sub-field) specific to any extent? Recall that in the introductory chapter we highlighted the fact that ILS are treated as generic overwhelmingly in the literature. However, we also noted some support for the notion that ILS are different across disciplines and in engineering as opposed to other fields, and indicated our sympathy with this view. Since the data for this study was collected, in fact, there is increasing evidence for support of this view in the “grey literature” of current professional communications and conference presentations, as mentioned in the literature review. This will be addressed again in the discussion chapter; however, it is worth noting here that likely this is a reflection of the recent inclusion of ILS skills among the related objectives or outcomes specified by accrediting bodies for engineering education worldwide, and the subsequent concern among those responsible for curricula about how these will be attained.

Over half (53%) of UOS professors and 23% of Concordia professors did not answer if ILS in engineering are generic. But over half of all respondents who answered this question (62% of UOS professors and 54% of Concordia respondents) said that ILS should be conceived with regard to their specificity in engineering. A few of the UOS professors through the survey, explained that engineering students are expected to have higher standards than others, and that engineering deals specifically with numbers and statistics. A few comments from Concordia professors shed more light on the ILS particularized in engineering. For example, one participant is not sure, and other participants confirm “data collection tools and techniques are standards”. Another professors highlights that “engineering information is a mix of mathematics, graphics technical reports and all of the above”, or “the skills needed are more elaborate in the field of engineering and also are more discipline dependent”.

Conclusion. Although a large proportion did not answer this question, over half the respondents subscribe to the view that it is important to understand ILS skills in an engineering-specific context. The professors further explain that while the "data collection and techniques are standard" engineering is a mix of theory and practice. Engineering is a design-oriented field and as such employs elements of both well-structured knowledge (mathematical formulae and models, scientific facts and principles) and ill-structured knowledge and thinking (there are many solutions to any problem and much of engineering involves a form of problem-solving described as "satisficing" -- meeting constraints with an acceptable solution -- rather than "optimizing" or finding the one "best" solution). There are, in addition, professional "soft" and technical skills – e.g., communication skills (writing, speaking, presentation, and negotiation skills), and representational skills.

The professors, through the focus -group exercises in both groups, emphasize this notion that engineering includes two main parts: theory and mathematics and more creative design and problem-solving oriented skills. Concordia professors in the focus group further suggested that the reason students appear to lack ILS skills in the first two years of studying, may be the very focus of the instruction and learning on the physics and mathematics required. This may mean either that ILS skills are not practiced or developed, or that the opportunity to observe or evaluate them is limited.

But do faculty expect students to come to their classes carrying some ILS? Fifty-eight percent of UOS professors expect students to come to their classes with already adequately developed ILS, as do 79% of Concordia professors. However, a few UOS professors further commented that students come to the classes without any training or any skills developed, according to the survey. Similarly, a few Concordia professors express the wish that students would walk into the classes with ILS. Similarly, UOS professors highlight the problem they have with students who start university without adequate ILS. They attribute this to the limitations of the formal education system students attend prior to entering their university-level engineering programs. They further explained that in UAE there are many different educational systems for the high school level reflecting different learning standards and, accordingly, students would gain different ILS skills. They further explain that only a few students come to the engineering program with an appropriate level of basic ILS. They added that GPA alone is not a sufficient criterion, on its own, to select students into the engineering program because some high schools might have different marking scales that do not really reflect students' achievements. UOS professors further suggest that students should pass a university exam to be accepted into the engineering program, in order to guarantee that students would have the minimum level of ILS needed to continue their studies successfully in the university program. Note their emphasis on entry standards and the supposition that students should enter with adequate skills, then build on these within their engineering studies.

Then we asked the participants: do students at different levels (seniority) have different ILS levels? Twenty-three percent of UOS professors and 12% of Concordia professors did not answer. But all UOS professors who responded believe that students in their third and fourth years, and graduate students, have better level of ILS, compared to

93% of Concordia professors who believe so. In the same vein, from the survey, we do not know the basis of this judgment. Concordia professors, through the focus group, highlight the fact that students in their first and second year do not have enough ILS due to the nature of the topics students have been focused on (pre-engineering is largely math and physics) and continue to focus on through the earlier portion of their engineering programs. According to Concordia professors in the focus group, engineering students need to focus, in the first two years, on the core theory engineering courses such as math and physics, and that engineering education becomes increasingly specialized, and addresses knowledge that is more fluid or evolving, after acquisition of fundamentals or grounding knowledge in the earlier part of the program.

In the focus group, Concordia professors emphasized the importance of the capstone project where, they believe, students develop their ILS. The capstone project is a project that engineering students complete with their peers, during the last few months of their programs, working under the close supervision of their teachers. As one Professor explained: “A group works together but there is a supervisor to guide them”.

Professors stress the importance of the capstone project to equip engineering students with the needed ILS to solve real-world engineering problems. As one participant remarked: “the quality is high, the students are always supervised and they have around eight months to complete the project so it is like a year-long endeavor. The end results we find them to be at the top”. Concordia professors expressed the view that it is through the capstone project they can ensure that ILS skills are addressed, and evaluate if engineering students graduate with satisfactory level of ILS.

But what do professors believe about students' ILS levels when graduating? Do students graduate with a good ILS level? Sixty-one percent of UOS professors and a comparable number of Concordia survey respondents (71%) believe that students graduate with good levels of ILS skills. However, a few UOS professors comment that "this is a critical issue", according to the survey.

On the other hand, how would professors know if graduate students have good ILS levels? Forty-one percent of UOS professors, and similarly, 47% of Concordia professors did not answer. About half (50% of UOS professors and 44% of Concordia professors) believe that they can evaluate students ILS level through projects and case studies. More Concordia professors (33%) than UOS professors (20%) believe regular assignments are a good evaluation tool for ILS level. The table (34) below provides percentages for the various possible sources of evaluation of ILS skills.

Table 34 - Profs - evaluate graduate students

How to evaluate graduating students' ILS	UOS Professors	Concordia Professors
Assignments	20%	33%
Ability to look for information, store and process them	20%	0
Projects and case studies	50%	44%
It is difficult to know	10%	0

Employers indicates high level of satisfaction	10%	0
Exam	0	11%
Presentations	0	11%
Graduate students survey	0	11%
Research level	0	11%
The students' performance on the course (before graduating)	0	11%

But what are the impacts of low ILS in graduate students? We asked participants their opinions regarding such impact on professions, engineering practice, and individuals. Nearly one-half of respondents -- 47% of UOS professors and 41% of Concordia professors -- did not answer this question, but the rest responded as follows:

Impact on profession. More of UOS' professors (55%) than Concordia professors (20%) believe that inadequate ILS would cost the profession more time and money. Twenty-two percent of UOS professors only believe it leads to "resources lost" and "less creativity". Other professors mention different negative implications such as: "difficult to maintain and advance in jobs", "bad results in general", "wrong decisions", or just "recession and migration of projects to other countries". The table 35 below summarizes the above survey results.

Table 35 - Profs - Impact of missing ILS on profession

Impact of missing ILS on Profession	UOS Professors	Concordia Professors
Lack of growth	11%	0
Time and money cost	55%	20%
Bad results in general	0	20%
Resources’ loss	22%	0
Less creativity	22%	0
Luck of solving problems	11%	20%
Wrong decision	11%	0
Very important	11%	0
Loss of reputation	11%	0
Difficult to maintain and advance in jobs	0	20%
Recession and migration of projects to other countries	0	10%

Impact on engineering. More Concordia professors (40%) than UOS professors (22%) believe low ILS leads to low standards in engineering. Meanwhile, more UOS professors (33%) than Concordia professors (10%) believe it leads to bad reputation and no credibility. Other professors believe lack of ILS in graduate students is critical for engineering, and would affect the progress of engineering without adding any new knowledge. Professors also believe it would prevent creativity and the ability to solve complex problems. The following table 36 further explains:

Table 36 - Profs - Impact of missing ILS on engineering practice

Impact of missing ILS on engineering practice	UOS Professors	Concordia Professors
Low standards	22%	40%
"Critical"	11%	0
No progress or new knowledge	22%	10%
Bad reputation and no credibility	33%	10%
Loss of society's confidence in the profession	11%	0
Inability to solve complex problem property	11%	0
No creativity	11%	10%

Impact on individual. The majority of Concordia professors (60%), compared with only 33% of UOS professors, believe that a lack of ILS in graduate students would affect the individuals' progress in the profession. Other professors believe it is not a good thing if the individual would like to have a better life and more success. However, a few UOS professors believe it is critical and would cause a low self-esteem, and the individual might seek “to compensate in other ways that may be unethical”. The following table 37 explains:

Table 37 - Profs - Impact of missing ILS on individuals

Impact of missing ILS on individuals	UOS Professors	Concordia Professors
Less self-confidence	22%	0
Inability to progress professionally	33%	60%
Critical	11%	0
Seeking to compensate in other ways that may be unethical	22%	0
It will not be good, for a better life or more chances for success	11%	10%
Inability to communicate with others or look for solutions	0	10%

But where or how do faculty believe students develop ILS? We used the Likert scale here, where participants can choose to evaluate the answer from 1 to 5:

1: not significant

2: not that significant

3: Neutral

4: significant

5: most significant.

About one-fifth (23% of UOS professors and 18% of Concordia professors) skipped answering this question. Nine percent of professors in both groups believe that home is a very significant place for students to obtain ILS and about one-fifth (23% of Concordia professors and 18% of UOS professors) believe home is a significant place, and 31% of Concordia professors compared to 18% of UOS professors believe it is Neutral. Similar proportions of respondents from both locations (27% of UOS professors and 23% of Concordia professors) believe home is not that significant but 27% of UOS professors compared to 15% of Concordia professors believe home is not significant at all. The below table 38 details:

Table 38 - Profs – students' ILS from home?

At home or on their own time:	UOS professors	Concordia Professors
5 - very significant	9%	8%
4 – significant	18%	23%
3 – Neutral	18%	31%
2 – not that significant	27%	23%
1 - not significant at all	27%	15%

On the other hand, almost half of the respondents (UOS: 46%, Con: 50%) believe that students gain their ILS significantly through previous levels of formal education, and this is the perspective that UOS Professors also emphasized through the focus group.

They further explained that there are different formal educational systems (private high schools) in the region that do not fully equip students with the needed ILS although students' GPs are high. But no Concordia professors would consider the formal educational system as not that significant to not significant at all The below table 39 explains:

Table 39 - Profs - students; ILS from previous level of formal education

Through previous levels of formal education:	UOS professors	Concordia Professors
5 - very significant	31%	21%
4 – significant	46%	50%
3 – Neutral	15%	29%
2 –Not that significant	0%	0
1 - not significant at all	7%	0

In addition, the majority of the professors (UOS: 61%, Con: 71%) believe that activities in the engineering programs would be a significant source for students' ILS. Concordia professors highlighted this issue through the focus group also when they emphasized that students get most of their ILS through the capstone at the last year of the engineering programming. They also stressed how ILS are part of the courses' outcomes and they expect students to adapt these skills throughout their university studying. They also stressed the importance of the project including the close contacts, especially for graduating students, with their supervisors where they gain all of these ILS.

In general, the results for these last two items reveal that faculty consider formal education more important than "home" experiences or opportunity for developing ILS.

In the same vein, UOS professors, through the focus group, emphasize that they make sure that students understand the needed skills for the classes and acquire them, even if professors themselves need to verify this many times, through the assignments and projects. No professor from either university believes that the activities in the engineering program are not that significant or not significant at all. The following table 40 provides the details:

Table 40 - Profs - students' ILS from engineering program

Through activities in your engineering program	UOS professors	Concordia Professors
Very significant	31%	14%
Significant	61%	71%
Neutral	7%	14%
Not that significant	0%	0
Not significant at all	0%	0

On the other hand, half of the professors (UOS: 50%, Con: 54%) believe that activities in other formal university level courses are also significant for students' ILS.

Notably the response is somewhat less strong than for courses within the engineering program, above. The below table 41 has the details:

Table 41 - Profs - Students' ILS through activities in university

Through activities in other formal university level courses	UOS professors	Concordia Professors
Very significant	0%	15%
Significant	50%	54%
Neutral	42%	31%
Not that significant	0%	0
Not significant at all	8%	0

In summary, professors highlight the importance of the formal education system, and the role of activities in the university courses to equip students with ILS, but the majority believes that it is the engineering program, above all, that allows students to gain these IL skills. The Concordia professors also highlight that students gain ILS through projects and classes, but especially through the capstone project.

Professors who participated in the focus group at Concordia University provide additional nuances concerning how engineering students gain their ILS. The professors mention the supervisor as the main sources, then "their colleagues, they work in labs where there is a generation of students who are senior in a way and others who have just joined in. So the newcomers learn from those who are more experienced and again they interact with their supervisors and they get feedback on that. They also attend conferences". In addition, again Concordia professors emphasize the important of the senior capstone project, where students learn most of their ILS. In the preparation phase for the capstone project, according to Concordia professors, an appointed engineering professor would go around the engineering department and give workshops and seminars preparing the students for this important project. However, there are not enough information about these workshops and seminars.

However, what are the best ways to learn and develop ILS? Close to half of the professors (UOS: 47%, Con: 41%) did not answer this question. But 23% of Concordia professors, compared with 33% of UOS professors, believe courses are the best way to develop ILS. Only 33% of UOS professors believe assignments are the best way to develop ILS. Then, 11% of UOS professors' answers vary between high school, learning by doing, workshops, self-learning or learning though examples and cases.

Only nine percent of Concordia professors identified a variety of other ways such as: practice, research, accreditation, or "specialist in education". The following charts 6 & 7 offer the details:

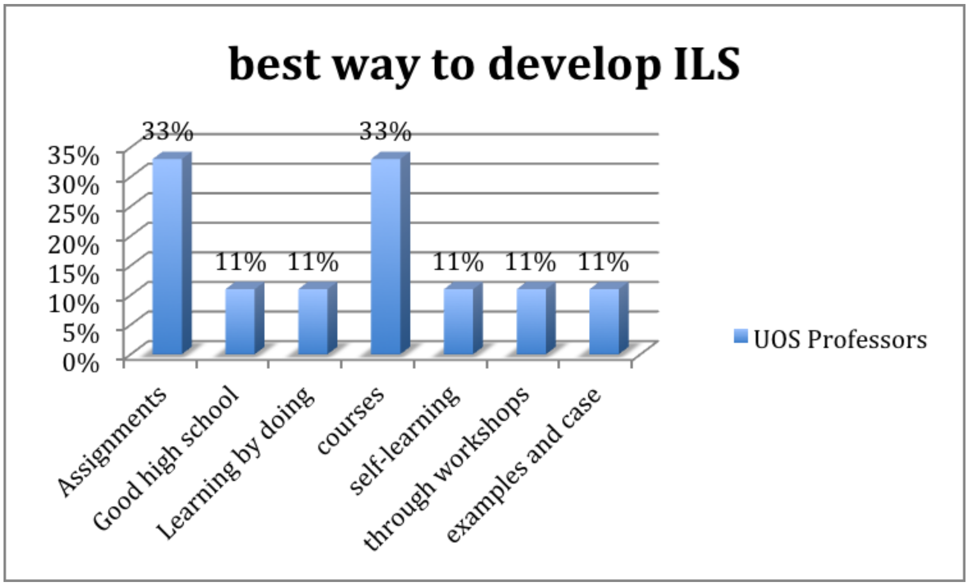


Figure 6 – UOS Profs - Best way to deliver ILS

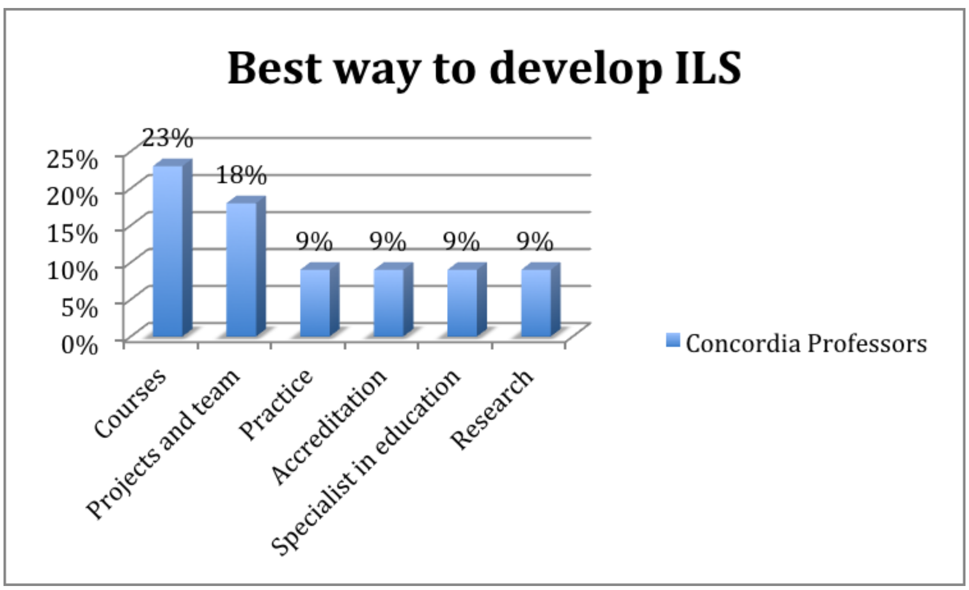


Figure 7 - Con Profs - Best way to deliver ILS

Next, to fill the gaps regarding our knowledge of the ILS in engineering, we need to know what are the representative examples of how ILS are used in: engineering, academic programs, and in the professional practice of engineering. A very high proportion of professors (UOS: 65%, Con: 70%) did not answer this question, but those who responded provide different examples.

ILS representative examples in engineering. According to the survey, 33% of UOS professors believe searching for standards that are always changing is a good example of ILS in practice. The other responses include: assignments, solving problems, doing research, and using different software programs. But 40% of Concordia professors believe the examples are in the service or support of: course projects, software applications, or programming. The rest identify: writing reports, metrics of the program assessment or search for standards. The following tables 42 & 43 have the details:

Table 42 - UOS Profs - ILS representative in engineering

ILS representative in engineering	UOS Professors
Assignments	16%
Understanding and discussing a technical paper	16%
Diverse software programs	16%
Management information system	16%
Search for standards that are always changing	33%
Find solutions	16%
Research skills	16%

Table 43 - Con Profs - ILS figure in engineering

The ILS figures in engineering	Concordia Professors
Course projects	40%
Software application	40%
Programming	40%
Courses (critical thinking)	20%
Writing report	20%
Metrics of the program assessment	20%
Search for standards	20%

How do ILS figure in academic programs and courses? Thirty-four percent of UOS professors identify lifelong learning skills, and team working skills in their response. The rest include doing projects and cases studies, and “ILS are highlighted in the course outlines”. See the following table (44) for details.

Table 44- UOS Profs - ILS figures in academic program

ILS figure in the academic programs and course	UOS Professors
Life long learning skills as the objectives of the engineering program.	34%
Case studies including problem solving activities	17%
Team work	34%
ILS are highlighted in the courses outlines	17%
Highlighted in the program outline	17%
Doing projects	17%

Meanwhile, the leading response choice of Concordia professors is that ILS figure in academics through assignments. Others mentioned programming, and elective courses. The below table (45) has the details:

Table 45- Con Profs - ILS figures in academic program

ILS figure in the academic programs	Concordia Professors
Research and paper reading	11%
Use of new engineering software	11%
Programming	22%
Through projects	11%
Through assignments	33%
Elective and embedded in undergraduate course	22%
It depends on the program's outcome.	11%

ILS figures in the professional practice. Half of UOS professors identify the engineers' attempt to solve new and unfamiliar problems. The rest mention either report writing or searching for new information. But Concordia professors identify different issues such as: better team-working, programing and information retrieval. The below table (46) has the details the UOS professors' opinions only because Concordia professors' opinions cant be grouped:

Table 46 - UOS Profs - ILS figures in the professional

ILS figure in the professional practice of engineering	UOS Professors
Engineer's attempt to solve new and unfamiliar problems	50%
In report writing	17%
Search for information and new knowledge	17%

But Concordia professors answer as the following:

- "Keep updated with the new design codes and standards, and new software"
- "Programming and information retrieval"
- "Better team working"
- "Everyday through presentations, meetings, telecoms, etc."

We also asked the participants: how do students in your field generally acquire these skills? Forty-one percent of UOS professors and more than one-half (53%) of Concordia professors skipped answering this question. However, half of the professors who answered believe that students acquire ILS in engineering through university studies and courses. Fewer believed they acquire ILS through assignments and projects and workshops. The following tables have the details:

Table 47- UOS Profs - How students acquire ILS

How do students in your field generally acquire these skills	UOS Professors
Through assignments, projects	40%
Through university studying including courses	50%
Group work	20%
Self learning	20%

Table 48- Con Profs -How students acquire ILS

How do students in your field generally acquire these skills	Concordia Professors
Through working with their supervisor	12%
Through workshops, seminars:	24%
Through capstone project	12%
Through courses (graduate)	50%
Through friends	12%
Through self learning	12%
On the job usually	12%

Then we ask the participants: how critical are these skills in the profession and why? Over half of respondents (53% of UOS professors and 59% of Concordia professors) skipped this question. But the majority of professors who answered believe that these skills are "very critical" in the profession to solve problems, though without explaining how and why they are very critical. The below table (49) explains the answers of the UOS professors, but the answers of Concordia professors cannot be grouped (explained below) due to their diversities.

Table 49- UOS Profs - How critical ILS in profession

How critical are these skills in the profession and why	UOS Professors
Critical for reasons mentioned above	24%
Very critical	37%
For solving problems	24%
For quality or safety or planning	12%
The professional is dynamic and changes with time and new knowledge is needed to perform tasks	12%

Concordia Professors: Concordia professors who responded were unanimous in judging these skills as “very critical”. Nearly one-third of the respondents did not add any further comments or explanations, but 70% of those who responded in this category provided the following reasons:

- The profession is dynamic, and requires continuous searching for new knowledge.
- Engineers need to write reports and presentations, and to master computer skills.

In the survey, we also asked the participants: can ILS be measured or evaluated? Fifty-nine percent of both UOS professors and Concordia professors skipped answering this question. But 86% of UOS professors who responded answered “yes”, and 17% are not sure. However, 67% believe they can measure ILS through students’ work and 17% believe it is “subjective” matter. On the other hand, fourteen percent of Concordia professors believe ILS can’t be measured. However, the rest of the professors who believe that they can be measured explained as the following:

- “Could be measured in a qualitative manner, then using quantitative measures”
- “Through evaluating presentation and writing reports”
- “Subjectively”
- “Through a rubric”
- “How fast and accurate in searching for information”

When we asked the participants “What do you believe is the best solution to develop ILS in the context of engineering education?” fifty-four percent of the professors believe that an independent or stand-alone ILS course for engineering is the best solution to develop ILS in the context of engineering education. Forty-six percent preferred to include ILS materials within each engineering topic, 30% prefer to provide independent ILS development for all disciplines, and only 23% believe that libraries should play that role. Twenty three percent in both universities skipped answering this question.

But who should teach ILS in engineering?

UOS professors:

Sixty-one percent of UOS professors believe that educators with specialized skills should teach ILS materials to the engineering students, while 54% believe that these materials should be taught by engineers themselves, and only 1 respondent (of 17 total) believes that librarians should teach these materials. It is good to mention here that participants could choose more than one answer.

Concordia professors:

Thirteen percent believe that librarians should teach ILS to engineering students, , 40% believe that specialized educators for engineering should teach ILS materials, and 73% believe that engineering professors should teach ILS to the engineering students.

Underlining the predominant view from the survey – that engineering professors should teach these skills -- one Concordia professor who participated in the focus groups highlighted the importance of having the engineering professors teach ILS to engineering students, so students can first recognize the importance of these skills, and what kind of skills are involved. They then need to learn how and where they need to apply these skills – knowledge which the engineering professors should possess and be able to impart. He further adds that a librarian could participate in such a course to point out the technical issues related to these skills. This reflects what Tucker and Palmer (1999) suggest concerning teaching engineering students ILS by engineering professors in collaboration with librarians.

Then we ask the participants: are there any obstacles for developing ILS? Response rates were low: 70% of UOS professors compared with 47% of Concordia professors skipped answering this question. It should be noted that this is an open-ended question. The tables (50 & 51) below explain the answers:

Table 50- UOS Profs - Obstacles for delivering ILS

Any obstacles for developing ILS	UOS Professors
Resistance to change	2
Dense curriculum	1
Different engineering disciplines need different skills	1
No obstacle	1
Students' abilities to learn are different.	1

Table 51- Con Profs - Obstacles

Any obstacles for developing ILS	Concordia Professors
Budget	9%
The curriculum is already crowded	18%
Each discipline needs different ILS	9%
Students depends on Professors for information	9%
The system	9%

Finally we asked the participants: what are the changes that are needed in engineering education to achieve a good level of ILS standards? A high percentage of professors (UOS: 59%, Concordia: 58%) did not answer this question, but the rest of the UOS professors provided the following responses to this open-ended item: "Focusing more on integrated solutions to engineering problems"; "Integrate ILS into teaching methodology"; "Improve reading, writings and research skills"; "Include ILS in the courses"; "Teach these skills"; and "Change the system".

Meanwhile, the Concordia professors provided the following answers:

- "It has to be adopted by the CEAB (the Canadian Engineering Accreditation Board). This would enforce incorporating it in the engineering curriculum.[2]",
- "Changes to structure of the courses to include ILS on the courses",
- "General courses for engineers and guidelines for different disciplines to be followed in specialized courses",
- "Receiving circular notes from librarians and education departments as refreshers courses",
- "Increase program length by adding a compulsory one team industrial training course",
- "Evaluating their knowledge on engineering ethics, principles, standards in class", "Adding courses related to ILS".

On the other hand, Concordia professors in the focus group highlight that engineering students at the graduate level, especially the doctoral level, would have a better level of ILS since they are interacting with their supervisors and striving to develop new knowledge or applications.

Professors' understanding of the meaning of the IL skills. For more understanding about the situation of ILS in engineering, and to be able to solve the perceived problem of low ILS levels in engineering graduate students, we need to have deeper understanding of the engineering professors' thinking and experiences. As mentioned earlier, this is also a specific gap in the literature that addresses the problem. While this literature, as limited as it is, addresses perceptions of ILS levels, the importance of ILS and, to some extent, the direction of solutions, there is no examination

---

[2] As mentioned earlier. This in effect has happened

in the peer-reviewed empirical research of the conceptions engineers hold, specifically, of ILS, of their conceptions of how ILS develop or their beliefs concerning how they developed their own IL competencies

Teaching style. We asked survey participants, if they assign a mid-term paper, what would they do? 18% of UOS professors comparing to 12% of Concordia professors did not answer the question. But 57% of UOS professors comparing to 60% of Concordia professors who answered this question, would include guidelines and instructions about how to write a paper when assigning a mid term paper, but 43% of UOS professors comparing to 40% of Concordia professors would assume that students know how to write such a term paper.

When asking the participants about their response when students are not able to produce a course paper or assignment, 12% of UOS and 6% of Concordia professors did not answer this question. But 67% of UOS professors compared to 44% of Concordia professors indicated they provide additional feedback or support to the students themselves when students fail to reflect good writing skills. Across the two groups, less than half would assign a low grade based on inferior writing skills – believing their role is not to teach writing skills. But more UOS professors (53%) than Concordia professors (31%) would assign a lower grade based on poor writing performance.

Seven percent of UOS professors compared to 44% of Concordia professors direct the students to other places in the university to seek help. This difference may simply lie in the support available. Writing skills service courses are readily available as recourse to Concordia students. The same mechanism is not available at UOS.

We asked the participants: Do you usually ask students to acquire different skills that you are not teaching? About one fifth (18% of UOS professors compared to 23% of Concordia professors) did not answer this question. Thirty-six percent of UOS professors and 46% of Concordia professors do not usually ask students to acquire different skills. But 64% of UOS professors compared to 23% of Concordia professors ask students to attain skills other than those he or she teaches. The following table (52) summarizes these skills:

Table 52- Profs - skills outside the class

Skills to have outside classes	UOS Professors	Concordia
Programming knowledge	14%	18%
How to use information, technology and math skills	7%	0
English language skills	28%	9%
Self-learning	7%	0
Communication skills	7%	21%
Team work	7%	0
Software usage	7%	18%

The above table (52) shows that language skills or proficiency is a main request for UOS professors. UOS faculty also expect students to obtain skills that Concordia professors do not ask for, such as team work, independent learning, math and information and technology usage. Does that mean Concordia students already have these skills that UOS students lack, or that Concordia professors consider such skills as part of their teaching objectives? The reason is not clear through this question but recall that other answers from different questions emphasize that UOS students need skills when starting university and certain classes. Math, English language, team-work and information and technology usage and the life-long learning skills are the main skills needed.

UOS professors who participated in the focus group emphasized the importance of the formal education provided at the high school level in order to prepare students with good ILS that help them when starting university. Professors complained that students lack a lot of important skills when they start the engineering program, such as math, English language, communication skills, independent learning skills and information and technology usage.

But do professors communicate the expectation that students should have these skills in their class? Most participants in the survey responded to this question: only 12% of UOS professors and 6% of Concordia professors skipped answering this question.

Of those responding, a vast majority (93% of the UOS professors and 87% of Concordia professors) indicated that they communicate with their students, explaining to them that they should acquire such skills, mostly in the classes, at the beginning of the semester, or through examples.

Since teaching resources are one of the most important elements in engineering instruction, we asked the participants about the teaching resources they use. Only 27% of UOS professors compared to 67% of Concordia professors use other teaching resources such as: “videos, case studies, seminars”; “personal notes, research papers, manufacture stat sheets”; and “field trips, invited speakers, web, and library”; or “Personal Notes, Manufacturer Datasheets, Research papers”. And 67% of UOS professors, in contrast with only 33% of Concordia professors explained that they use the textbook as a primary source for teaching. In addition, 74% of UOS professors compared with 57% of Concordia professors do not believe that using only the text book is problematic.

How do they teach students the IL skills?

How do professors teach ILS? To address this dimension we asked the participants a few questions. We first want to know if professors incorporate any specific activities to develop ILS. Nearly half (41% of both UOS and Concordia professors) skipped answering this question. But, notably, 60% of the remaining professors who provided a response, from both universities, do not incorporate any specific activities or strategies to develop ILS in their own classes. Of the smaller number who indicate they do incorporate specific activities or strategies to develop ILS, three-quarters of the UOS professors would give group assignments, project and case studies to teach ILS. The following table (53) presents all the activities identified:

Table 53- UOS Profs special activities

Do you incorporate any specific activities to develop ILS	UOS Professors

Perform projects	25%
Give group assignments and project and case studies	75%
Indirectly through self studying	25%

Concordia professors, on the other hand, identified ILS related activities as asking students to do presentations, setting assignments and the capstone project.

But what is the perception of faculty regarding the role of the engineering professors in terms of developing and evaluating ILS? A big percentage of professors from both universities (UOS: 47%, Con: 41%) did not respond, but 44% of the rest of UOS professors believe that by giving assignments and projects to the students they help students to develop ILS. Other UOS professors believe they are there to guide, encourage, provide advice, help, and to facilitate, as the table 54 below explains:

Table 54 - UOS Profs - your role

Your role in developing ILS	UOS Professors
Encourage	22%
Guide	22%
Provide advice	22%
Give assignments and projects	44%
Facilitate	11%

Help	11%

Similarly, Concordia professors provided different answers such as “incorporate them in the course I teach” or “facilitate development through assignments and projects”. They also see themselves as helpers and as guiding students to the appropriate resources.

One of the guiding hypotheses of this study is that engineering professors lack a deep, shared understanding of the meaning of the ILS, which leads us to ask the participants how they define “information literacy”, and what are the skills, knowledge or dispositions involved? Thirty-five percent of the UOS professors and nearly one-half (47%) of Concordia professors skipped answering this question. In addition, 27% of the Concordia professors who responded claimed that they have no answer. Forty-five percent of the UOS professors who provided a response to this item, compared to only 10% of Concordia professors, believe ILS is about searching for information. A smaller proportion, about one third (36%) of UOS professors provided a statement that is close to the ALA definition for ILS. The below table 55 and figure 8 offer details:

Table 55 - Profs _ILS definition

ILS definitions	UOS Professors	Concordia
Exact ALA definition	0	10%
“Search for info”	45%	10%
“Work with info”	18%	10%

Closer to ALA definition[3]	36%	0
“State of art learning”	0	10%
“Computer knowledge”	0	20%
“Seek and retrieve knowledge”	0	10%
“Collect relevant info to a problem”	0	20%

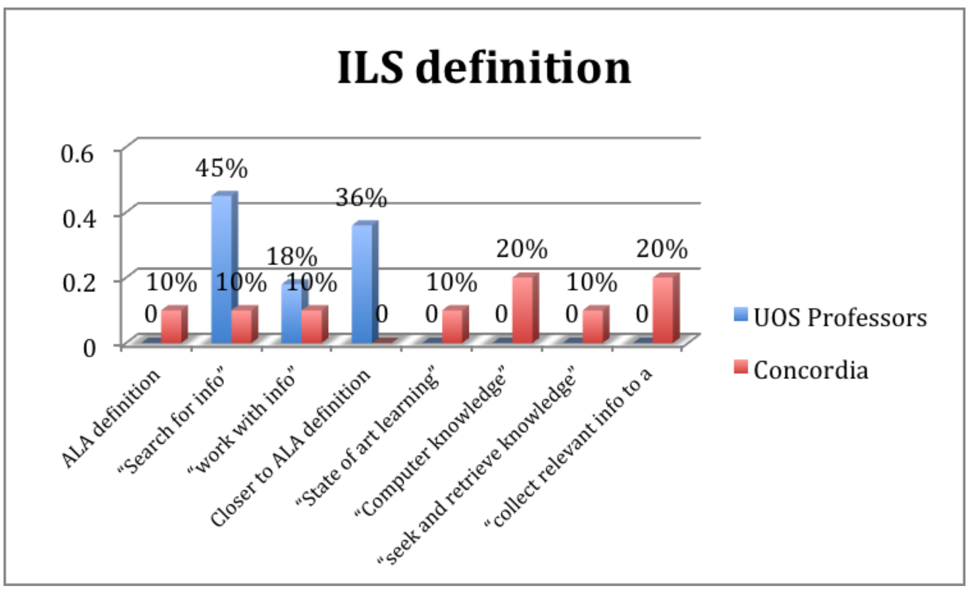


Figure 8 - Profs - ILS definitions

A Concordia participant in the focus group explained: "in engineering, most of these [ILS] skills are acquired primarily through interaction with the supervisor". He

[3] Participants gave definitions that are close to the ALA’s but not complete, missing some elements.

further explains: "these are what we refer to as sub skills; how students acquire them, differs from one to another and with different professors."

Then we asked the participants: has the “information revolution” had a major impact on engineering as compared with other fields? Twenty-nine percent of the UOS professors and 18% of Concordia professors skipped answering this question. But all the professors from both groups believe that the “information revolution” has had a major impact on engineering,

Do professors acquire all the IL skills?

It is conceivable that engineering professors have less than desirable levels of ILS or awareness of the significance of ILS, which leads to further questions included in the survey. We wanted to know, for example, if the participants have read any sources on the subject of ILS. A large majority (85% of UOS professors and similarly 87% of Concordia professors) claim that they had not read any materials on the subject of ILS.

We asked how they believe they develop these skills. A good percentage of professors from both universities (41%) did not answer this question. It must be recalled that there was considerable variability in the responses to items that addressed exactly what ILS are conceived to be, so, in effect, the answers provided to this current item are doubtless somewhat confounded. However, 59% of UOS professors who responded, compared to 30% of Concordia professors, claim they develop ILS through self-learning and 40% through their studying years in the university including attending workshops and seminars. In the same vein, 50% of Concordia professors claim that they develop their ILS through attending workshops, seminars, courses and using the internet, and through working. The tables 56 and 57 summarize the responses:

Table 56- UOS Profs - develop ILS yourself

How did you develop these skills	UOS Professors
Through the task of preparing lectures	10%
Solving problems	10%
Conducting research	10%
Self-learning	59%
Very good high schooling system	10%
Through university studying including workshops and seminars	40%

Table 57- Con Profs - Develop ILS yourself

How did you develop these skills	Concordia Professors
Through continuous readings	10%
Workshops, seminars, courses and	50%

Internet	
Trial and error after graduating (self learning)	30%
My colleagues	20%
Working with my students	10%
Through working	50%

We asked professors to to evaluate their own ILS levels. Twenty-three percent of UOS professors and 18% of Concordia professors did not provide a response to this item. The participants could choose one of the following points on a five-point Likert scale to evaluate their own ILS level: very strong, strong, adequate and needs strengthening.

Sixty-nine percent of UOS professors believe that they have strong ILS while the remaining 31% characterize their ILS as adequate. Of the Concordia professors responding to this item, 14% believe they have very strong ILS, while about the same proportion as UOS faculty (67%) believe they have strong ILS. Fourteen percent of Concordia professors believe they have adequate skills, but no one, form either group, believes that his or her ILS needs any strengthening.

Then we asked the participants: are you aware of any position taken by your professional accreditation body regarding the importance of ILS skills, or concerning objectives for engineering education programs that refer to ILS skills?

About one-fifth of participants (23% of UOS professors, 18% at Concordia) skipped answering this question. Of those who provided a response, over half (54% of UOS professors and 64% of Concordia professors) are not aware of any position taken by their professional accreditation body regarding the importance of ILS. Only 38% of UOS professors and even less (14%) of Concordia professors indicated awareness of a position taken by their professional accreditation body regarding the importance of ILS. A few Concordia professors provided further related comments: “Communication skills, social aspects of engineering, ethics and equity are emphasized besides technical skills such as analysis and design”, or “CEAB want skills to be included in the courses”.

Although the majority of the professors in both groups (54%: UOS, 64%: Concordia) are not aware of any position taken, Concordia professors who participated in the focus group talked in detail about the CEAB’s role in spreading ILS through recent requirements to include ILS in the engineering curriculum. In this regard, the focus group was likely not “representative”. It included three engineering chairs who were vocal in highlighting the importance of integrating ILS within the engineering curriculum. They went further in explaining that CEAB want these ILS to be part of the engineering curriculum within two years. Currently, this is recommended but not mandatory. In two years these ILS will be mandatory. The civil engineering at program at Concordia University is already working hard to make sure such an integration is successful in the coming two years. However, Concordia professors in the focus group highlighted that ILS are now already part of the stated outcomes of the department as a whole and that an expression of them is also included in each course outline. It was noted that although professors are not sure how to teach them, they are expecting students to pick up these skills.

Summary Of The Focus Group Of CU Professors:

The Professors of Concordia University in the focus group highlight very important issues related to ILS in engineering. It is good to mention that this focus group was a not representative of the faculty population, since a chair and two previous chairs contribute to the discussion.

The first important issues is that students in the first two years of their engineering studying lack the Information literacy skills and this is due to the heavy schedule they have where they need to focus on the hard science such as math and physics. The students, however, gain most of their ILS in the last year where they have to work for last eight months of their study, on their capstone project, which is a peer project, and work closely with their supervisors. A professor would go around through this period giving lectures about the different needed ILS for this project. On the other hand, graduate students have better ILS since they are working closely with their supervisors who become the main source of ILS.

The second issue is that the engineering curriculum is packed and there is no space to add any other courses related to ILS. Students need to be aware of the importance of these skills and seek the workshops that are offered by library.

Third, the participants highlight the importance of these skills for students' success and practice, especially that CEAB stress the importance of these skills as part of the outcomes. Although participants include these skills as part of their course outcome but they don't teach them directly, they expect students to pick up these skills throughout the activities of the course.

The focus group in UOS:

The participants in UOS focus groups raise many important issues related to ILS in engineering.

The first issue relates to students educational level when starting university; they all agree that a good percentage of the students start the engineering program and they lack needed skills, such as math and communication skills, although their GP is high. They attribute this problem to the different educational systems in the high school. It is known in the region that there are many private high schools that adapt different educational systems and accordingly the students' levels vary.

They also highlight the importance of ILS especially; nowadays, but they claim that students do not care to obtain these skills; their main goal is to graduate.

They also highlight that students in their third and forth year of studies have better ILS levels.

The Engineering Students

Demographic Information. A total of 54 students from CU University (CU) and 79 students from UOS responded to the student perceptions survey. Sixty percent of CU students are within their twenties, 37% are within their thirties, and only 2% are in their forties. The UOS cohort is comparatively younger with 99% of the students in the twenties. Both groups were predominately male: 74% of the CU and 81% of the UOS students. A similar majority within both groups came from Civil Engineering (72% of CU students and 69% of UOS students). A small number (2% of CU students and 6% from UOS) come from Mechanical Engineering. Twenty five percent of CU students come from Computer and Software Engineering Department. Twenty four percent come from Electrical Engineering in UOS.

In terms of seniority, 14% of both UOS and CU students are in the first year of their study; 7% of UOS students compared to 23% of CU students are in their second year. A larger proportion (36%) of the UOS students were in their third year as compared to 12% of CU students and 19% of UOS students compared to 7% of CU students are in the fourth year. 14% of UOS students compared to 12% of CU students are in Master. Only 9% of CU students are in the master program, and 23% are in the PhD program in CU University.

The largest difference between the two locations concerns work experience. A full 96% of UOS students compared with less than half (44%) of CU students do not have any working experience. It is good to mention that we don't have any data if respondents are part time or full time students.

What is ILS? Recall from chapter one (the introduction) that we set out to calibrate student perceptions regarding issues around ILS and compare them with faculty views. Any convergence or identity provides some level of validation of faculty perceptions. For example, what if faculty reports they believe they make the importance of ILS clear to students and students concur. This would validate or reinforce the faculty perception. On the other hand, if the views on this point diverge strongly, then there is an issue that needs to be addressed and further probed.

First, we asked students to define ILS. Fifty-two percent of CU students and a very large majority of UOS students (82%) did not answer this question. Furthermore, about half of those who responded (42% of CU students and 57% of UOS students) answered explicitly “I do not know”. The remaining students were able to provide a good definition of ILS, though it appears they were largely drawn directly from the ALA website, or another internet source stating the ALA position.

Second, we asked students where they heard about ILS. Sixty-two percent of UOS students and 39% of CU students did not answer this question. Thirty-three percent of those UOS students who responded compared to only 2% of CU students heard about ILS from courses; 10% of UOS students compared to 6% of CU students identified the program as a source; while only 7% of UOS students heard through assignments; 10% of UOS students and 3% from CU from a librarians; 17% of UOS students and 24% of CU students from the net; 20% of UOS students compared to 6% of CU from a peer; and 43% of UOS students compared to 64% of CU, through this survey.

Third, we asked the participants: How important are these skills in your engineering studies? We identified the skills using the framework adopted for this study, and employed a five-point Likert scale with the following points:

5: very important

4: important

3: neutral

2: not that important

1: not important

Thirty-one percent of CU students and a larger proportion from the UOS (58%) did not answer this question. But the rest provided different answers. See the table below providing the skills and answers and another table where we collapse “very important” and “important” into “important”, and “not that important” and “not important” into “not important”.

Access, store, and use information skills. The majority of the participants (UOS: 54%, CU: 60%) believe these skills are important, including the majority (UOS: 33%, CU: 38%) believe these skills are very important. However, 30% of UOS students compared to only 9% of the CU students believe these skills are not important. In the collapsed three-point scale, we see that a relatively high proportion (30%) of UOS students believe the skills are not important, a view shared by a smaller number (9%) of CU’s participants. The following tables (58 & 59) have the details:

Table 58- students - access info skills

Access, store and use information skills	UOS students	CU students
Very Important	33%	38%
Important	21%	22%
Neutral	15%	32%
Not that important	15%	6%
Not important.	15%	3%

Table 59 - student s- access info (comp)

Access info (collapse)	UOS students	CU students
Important	54%	60%
Neutral	15%	32%
Not important	30%	9%

T

Research skills. The majority of the students (UOS: 48%, CU: 60%) believe research skills are important for their success through studying engineering. But 26% of UOS students compared to only 8% of CU students believe these skills are not important, while a further 8% of CU students believe these skills are not that important. The details are in the following tables (60, 61):

Table 60- Students - research skills

Research skills	UOS students	CU students
Very important	30%	38%
Important	18%	22%
Neutral	27%	31%
Not that important	8%	8%
The least important.	18%	0

Table 61- students - research skills (comp)

Research skills (collapse)	UOS students	CU students
Important	48%	60%
Neutral	27%	31%
Not important	26%	8%

Knowledge of how to use applications for accessing, storing and using information sources (e.g., online library resources, Google, Flickr, social media..). The majority of the participants (UOS: 56%, CU: 53%) believe that these skills are important. But nearly one-fifth 1(8%) of UOS students compared with a very small percentage (3%) of CU students believe these skills are not important. The following tables (62 & 63) explain:

Table 62-students-using application

Use application for Info usage	UOS students	CU students
Very important	34%	25%
Important	22%	28%
Neutral	25%	44%
Not that important	6%	3%
The least important.	12%	0

Table 63-Students- Using application(comp)

Application usage (collapsed)	UOS students	CU students
Important	56%	53%
Neutral	25%	44%
Not important	18%	3%

Writing skills. Slightly more than half of the participants (UOS: 56%, CU: 54%) believe writing skills are important to their engineering studying. However, again, a larger proportion of UOS students (21% of UOS students as compared with 8% of CU students) believe these skills are not important. See tables (64, 65) below:

Table 64-Students - writing

Writing skills	UOS students	CU students
Very important	34%	35%
Important	22%	19%
Neutral	28%	38%
Not that important	12%	8%
The least important.	9%	0

Table 65-Students-writing (comp)

Writing skills (collapsed)	UOS students	CU students
Important	56%	54%
Neutral	28%	38%
Not important	21%	8%

Library skills. The results here are closer across the two groups and these skills are apparently viewed as less important than the previous ones reported above. Forty-two percent of UOS participants compared with 34% of CU participants believe library skills are important to their success. However, 29% of UOS and 23% of CU participants believe such skills are not important. The following tables (66, 67) explain:

Table 66-Students-Library

Library skills	UOS students	CU students
Very important	13%	14%
Important	29%	20%
Neutral	29%	43%
Not that important	16%	20%
The least important.	13%	3%

Table 67- Students - Library skills (comp)

Library skills (collapse)	UOS students	CU students
Important	42%	34%
Neutral	29%	43%
Not important	29%	23%

Visual skills. The majority of students: (both UOS and CU: 57%) believe visual skills are important, and 13% of UOS students compared to 9% believe they are not important. The following tables (68, 69) explain:

Table 68-Students- Visual skills

Visual skills	UOS students	CU students
Very important	23%	20%
Important	23%	37%
Neutral	42%	34%
Not that important	3%	9%
The least important	10%	0

Table 69-Students - Visual (comp)

Visual skills (collapsed)	UOS students	CU students
Important	46%	57%
Neutral	42%	34%
Not important	13%	9%

Communication skills. More UOS participants (69%) than CU Participants (47%) believe communication skills are important to their studies. Moreover, more UOS students (41%) believe these skills are very important (28% for CU). Twelve percent of UOS students, and similarly 15% of CU students, believe they are not important. The following tables (70, 71) explain:

Table 70-Students - Communication

Communication skills	UOS students	CU students
Very important	41%	28%
Important	28%	19%
Neutral	19%	39%
Not that important	6%	9%
The least important.	6%	6%

Table 71-Students - Communication (comp)

Communication skills	UOS students	CU students
Important for studying	69%	47%
Neutral	19%	39%
Not important	12%	15%

Social networking skills. More UOS participants (55%) than CU participants (41%) believe social networking skills are important. Thirty-two perent of UOS students compared to only 11% of CU students believe these skills are very important, and 19% of UOS students compared with 27% of CU students believe they are not important. See tables (72, 73) below:

Table 72-Students - Social networking

Social networking skills	UOS students	CU students
Very important	32%	11%
Important	23%	30%
Neutral	26%	32%
Not that important	16%	19%
Not important.	3%	8%

Table 73-Students - Social (comp)

Social networking	UOS students	CU students
Important	55%	41%
Neutral	26%	32%
Not important	19%	27%

Problem-solving skills. Overall, the majority of participants (UOS: 62%, CU: 79%) believe that problem-solving skills are important for their programs of study; whereas 52% of UOS students and 57% of CU students believe they are very important. On the other hand, 16% of UOS students compared to only 5% of CU students believe they are not important. The following tables (74, 75) explain:

Table 74 - Students - Problem solving

Problem solving skills	UOS students	CU students
Very important	52%	57%
Important	10%	22%
Neutral	23%	16%
Not that important	6%	5%
Not important.	10%	0

Table 75-Students - Problem solving (comp)

Problem solving (collapse)	UOS students	CU students
Important	62%	79%
Neutral	23%	16%
Not important	16%	5%

Critical thinking skills. The majority of the participants, overall, (UOS: 61%, CU: 78%) believe critical thinking are important for their studies. However, these skills registered as more important with the CU students. Only a third (32%) of UOS students compared to half of CU students believe these skills are very important. 38% of UOS students responded with a neutral or not important choice compare to 23 % of CU students. Only students from the UOS cohort responded that these skills are categorically not important (16%). See tables (76, 77) below:

Table 76 -Students - Critical thinking

Critical thinking skills	UOS students	CU students
Very important	32%	50%
Important	29%	28%
Neutral	19%	17%
Not that important	3%	6%

Not important	16%	0

Table 77 - Students - Critical thinking (Comp)

Critical thinking	UOS students	CU students
Important	61%	78%
Neutral	19%	17%
Not important	19%	6%

Decision making skills. The majority of the participants (UOS: 55%, CU: 77%) believe decision-making skills are important, overall. Thirty-nine percent of UOS compared with 31% of CU students believe they are very important. However, 29% of UOS students compared with 20% of CU students believe they are neutral and 16% of UOS students compared to 3% of CU students believe they are not important, including 13% of UOS students only who believe they are not important at all. As with problem-solving skills this competence is viewed as more important within the CU cohort. The details are in the following tables (78, 79)

Table 78- Students - Decision making

Decision making skills	UOS students	CU students
Very important	39%	31%
Important	16%	46%
Neutral	29%	20%
Not that important	3%	3%
Not important	13%	0

Table 79 - Students - Decision making (comp)

Decision making	UOS students	CU students
Important	55%	77%
Neutral	29%	20%
Not important	16%	3%

Knowledge of Professional Standards. Fifty-six percent of UOS students compared to 67% of CU University students believe professional standards are important; whereas 22% of students from both groups believe these groups are very important. However, 22% of UOS students compared to 19% of CU students believe they are neutral and 22% of UOS students compared 13% of CU students believe they are not important, including 12% of UOS students only who believe they are not important at all. The following tables (80, 81) explain.

Table 80- Students - Professional

Knowledge of professional standards	UOS students	CU students
Very important	22%	24%
Important	34%	43%
Neutral	22%	19%
Not that important	10%	13%
Not important	12%	0

Table 81-Students - Professional standards (comp)

Professional standards	UOS students	CU students
Important	56%	67%
Neutral	22%	19%
Not important	22%	13%

Ethics skills. Sixty-nine percent of UOS students compared to 61% of CU students believe ethics skills are important to their studies, including 45% of UOS students compared to 33% of CU students who believe they are very important. Meanwhile, 13% of UOS students compared to 25% of CU students believe they are neutral, and 16% of UOS students compared to 14% of CU students believe they are not important. The following tables (81, 82) explain:

Table 82-Students - Ethics

Ethics skills	UOS students	CU students
Very important	45%	33%
Important	26%	28%
Neutral	13%	25%
Not that important	6%	11%
Not important	10%	3%

Table 83-Students - ethics (comp)

Ethic skills	UOS students	CU students
Important	69%	61%
Neutral	13%	25%
Not important	16%	14%

Then we asked the participants: How important are the following skills for engineering practice? We again employed a five-point Likert scale.

About one-third of respondents (31% of CU students, 39% of the UOS students) did not answer this question, but the following tables highlight the differences in answers from those who completed the item.

Research skills. Half of the students in both groups believe that research skills are important. Thirty-four percent of UOS students compared to 27% of CU believe they are neutral and 16% of UOS students believe they are not important compared with 22% of CU students noting that all the 10% of UOS students believe these skills are not important at all. While the pattern of responses on the scale is different, collapsing the scale in to three points results in what appear to be similar perspectives. The following tables (84 & 85) explain:

Table 84-students- research for work

Research skills	UOS students	CU students
Very important	31%	19%
Important	19%	32%
Neutral	34%	27%
Not that important	0	19%
Not important.	16%	3%

Table 85-students-research for work (comp)

Research skills	UOS students	CU students
Important	50%	51%
Neutral	34%	27%
Not important	16%	22%

Knowledge of applications for information access. Fifty-nine percent of UOS students compared to 54% of CU students believe knowledge of applications knowledge for accessing information is important for engineering practice where 25% of UOS students compared to 19% of CU students believe it is very important. Meanwhile, 25% of UOS students compared to 19% of CU students believe it is neutral and 25% of UOS students compared to 27% of CU's believe it is not important. Here the viewpoints seem very close. The following tables (86 & 87) explain:

Table 86-Students - application for work

Knowledge of application	UOS students	CU students
Very important	25%	19%
Important	34%	35%
Neutral	25%	19%
Not that important	3%	27%
Not important	12%	0

Table 87-Students - application for work (comp)

Application knowledge	UOS students	CU students
Important	59%	54%
Neutral	25%	19%
Not important	15%	27%

Writing skills. Fifty percent of UOS students compared to 43% of CU students believe writing skills are important to the engineering practice. Meanwhile, 25% of UOS students compared to 13% of CU students believe they are neutral and 18% of UOS students compared to 25% of CU students believe they are not important. The following tables (88 & 89) explain:

Table 88-students - writing for work

Writing skills	UOS students	CU students
Very important	31%	32%
Important	25%	30%
Neutral	25%	13%
Not that important	12%	22%
Not important.	6%	3%

Table 89-students - writing for work (comp)

Writing skills	UOS students	CU students
Important	50%	43%
Neutral	25%	13%
Not important	18%	25%

Library skills. Overall, about one-third of the students (30% of UOS students, 27% of CU students) believe that library skills are important. Nearly three-quarters (71% of UOS students and 73% of CU students) offered a neutral or lacking importance response. Clearly, the students place a low value on library skills. The following tables (90,91) explain:

Table 90-students - Library skills for work

Library skills	UOS students	CU students
Very important	17%	3%
Important	13%	24%
Neutral	27%	38%
Not that important	27%	24%
Not important.	17%	11%

Table 91-students - Library skills for work (comp)

Library skills	UOS students	CU students
Important	30%	27%
Neutral	27%	38%
Not important	44%	35%

Visualization skills. Over half (53% of UOS students, 65% of CU students) believe that visual skills are important in the engineering practice. Twenty-eight percent of UOS students compared to 27% of CU students offered a neutral response, while 18% of UOS students and only 3% of CU students believe they are not important. The following tables (92, 93) explain:

Table 92-students - visual skills for work

Visual skills	UOS students	CU students
Very important	28%	32%
Important	25%	38%
Neutral	28%	27%
Not that important	6%	3%
Not important.	12%	0

Table 93-students -visual for work (comp)

Visual skills	UOS students	CU students
Important	53%	65%
Neutral	28%	27%
Not important	18%	3%

Communication skills. The majority of the participants (UOS: 63%, CU: 77%) believe communication skills are important in the engineering practice; whereas 44% of UOS students compared to 51% of CU students believe these skills are very important. Almost double the proportion of UOS compared with CU students view these skills neutrally or as not important. See tables (94, 95), below:

Table 94-students-communication for work

Communication skills	UOS students	CU students
Very important	44%	51%
Important	19%	27%
Neutral	22%	13%
Not that important	10%	8%
The least important.	6%	0

Table 95-students-communication for work (comp)

Communication skills	UOS students	CU students
Important	63%	77%
Neutral	22%	13%
Not important	16%	8%

Social networking. The majority of the participants (UOS: 66%, CU: 68%) believe social networking skills are important in the field. Sixteen percent of students in both universities have no strong opinion, and 18% of UOS students compared with 16% of CU students believe these skills are not important. The following tables (96 & 97) give details:

Table 96-students-social networking for work

Social networking skills	UOS students	CU students
Very important	41%	30%
Important	25%	38%
Neutral	16%	16%
Not that important	12%	11%
The least important	6%	5%

Table 97-students-social networking for work (comp)

Social networking skills	UOS students	CU students
Important	66%	68%
Neutral	16%	16%
Not important	18%	16%

Problem-solving skills. The majority of the participant (UOS: 71%, CU: 89%) believe problem solving skills are important; whereas 58% of UOS students compared to 51% of CU students believe these skills are very important. Twenty-nine percent of UOS students have no strong opinion or view the skills as lying on the continuum of not important, compared with only 11% of CU students. The following tables (98, & 99) have the details:

Table 98-students - problem solving for work

Problem-solving skills	UOS students	CU students
Very important	58%	51%
Important	13%	38%
Neutral	13%	8%
Not that important	6%	3%
Not important at all	10%	0

Table 99-students-problem solving for work (comp)

Problem solving skills	UOS students	CU students
Important	71%	89%
Neutral	13%	8%
Not important	16%	3%

Critical thinking skills. The majority of the participants (UOS: 67%, CU: 87%) believe critical thinking skills are important; whereas 48% of these UOS students compared to 57% of these CU students believe these skills are very strong. Consistent with the pattern for many other responses: more CU students characterize these skills as very important than UOS students, and a larger proportion of UOS students view these skills in a neutral or negative (not important) light (33% versus 14% at CU). The following tables (100 & 101) have the details:

Table 100-students- critical thinking for work

Critical thinking skills	UOS students	CU students
Very important	48%	57%
Important	19%	30%
Neutral	10%	11%
Not that important	13%	3%
Not important al all	10%	0

Table 101-students-critical thinking for work (comp)

Critical thinking skills	UOS students	CU students
Important	67%	87%
Neutral	10%	11%
Not important	23%	3%

Decision-making skills. The majority of the participants (UOS: 68%, CU: 81%) believe decision-making skills are important for engineering practice; whereas, in this case, a larger proportion (62%) of UOS students as compared with CU students (51%) believe these skills are very important. The tables (102, 103) below have the details:

Table 102-students - decision making for work

Decision making skills	UOS students	CU students
Very important	62%	51%
Important	6%	30%
Neutral	19%	13%
Not that important	3%	3%
Not important at all	9%	3%

Table 103-students-decision making for work (comp)

Decision making skills	UOS students	CU students
Important	68%	81%
Neutral	19%	13%
Not important	11%	6%

Knowledge of professional standards. The majority of the participants (UOS: 69%, CU: 80%) believe professional standards are important; whereas half of these students in both groups believe these skills are very important. Again a somewhat larger proportion of UOS students believe the skills are not important. The tables (104, 105) below explain:

Table 104-students-professional standards for work

Knowledge of professional standards	UOS students	CU students
Very Important	50%	50%
Important	19%	30%
Neutral	12%	16%
Not that important	6%	5%
Not important at all	12%	3%

Table 105-students- professional for work (comp)

Professional standards skills	UOS students	CU students
Important	69%	80%
Neutral	12%	16%
Not important	18%	8%

Ethics skills. The majority of the participants (UOS: 65%, CU: 74%) believe ethic skills are important; whereas about half of these students in both groups believe these skills are very important. Meanwhile, 23% of UOS students compared to only 3% of CU students believe these skills are not important, noting that these 3% of CU students only believe that these skills are not that important. The tables (106, 107) below explain:

Table 106-student-ethics for work

Ethics skills	UOS students	CU students
Very important	55%	53%
Important	10%	21%
Neutral	13%	23%
Not that important	10%	3%
Not important at all	13%	0

Table 107-students-ethics for work (Comp)

Ethic skills	UOS students	CU students
Important	65%	74%
Neutral	13%	23%
Not important	23%	3%

Skills to start university. But are engineering students aware of any skills needed to start university? A very high percentage, three-quarters (76%) of UOS students and nearly half (41%) of CU students did not answer this question. The remaining participants provided the following answers. Note that a respondent could nominate more than one skill. Table 108 shows the details:

Table 108-students-skills to start university

Skills needed when starting university	UOS	CU students
Negotiation skills	0	3%
knowledge of professional standards	0	3%
Information search	0	9%
Communication skills	53%	22%
Math skills	0	3%
Basic reading and Comprehension ability and writing skills.	25%	28%
Team work	0	6%
Research skills	10%	28%
Decision-making skills	10%	9%

Skills needed when starting university	UOS	CU students
Computer and software knowledge	10%	12%
Problem-solving skills	15%	12%
Critical thinking	10%	12%
Library skills	0	6%
Self-learning skills	5%	18%
Ethics	10%	3%
Professional experience	0	3%

Summary. To summarize, with regard to this item, the proportion of responses concerning computer and software skills, problem-solving, critical-thinking, decision-making and reading and writing skills were similar across the two groups. A greater proportion of respondents from CU than from UOS identified research, library and information search skills, as well as independent learning skills. More UOS than CU students identified communication skills (not surprising, perhaps, in an academic environment where the language of instruction is not the students' first language) and ethics. There was some awareness of teamwork negotiation skills and knowledge of professional standards within the CU group, but no mention of these elements by UOS students.

Skills those become more important with advancement through the program. We posed the following open-ended question: "With regard to the skills and knowledge that are important during your academic studies in engineering, do these change from one year to the next? (Y/N) If so, what skills become important or more important as you progress?" Forty-four percent of CU students and 77% of UOS students skipped answering this question. Among the UOS students providing a response, 17% answered "no", "5" wrote "no idea" and "78% answered "yes".

The below table (109) displays the skills that students believe become more important with their progression through an engineering program

Table 109-students-skills becoming more important

Skills that become important	UOS students	CU students
Research skills	5%	15%
Programming language	5%	3%
Critical thinking	0	6%
Self learning skills	0	6%
Writing skills	0	6%
Knowledge of professional	5%	3%
Engineering knowledge	0	3%
Library skills	0	3%

Skills that become important	UOS students	CU students
Communication skills	27%	9%
Decision making	10%	9%
Software skills	0	3%
Problems solving	22%	6%
Negotiation	0	3%
Social networking	5%	0
Ethics	5%	0
Team working	5%	0

Summary. Here, UOS students emphasized communication skills, once again, and problem solving skills , while making some mention of ethics, social networking and team work, which are absent from the CU responses. CU respondents emphasize, again, research skills, while making some mention of critical thinking, independent learning and writing and library skills.

There is some slight variance with the elements identified by each group from the previous item but overall we see, again, an emphasis on communication skills at UOS, and research and other ILS skills at CU.

Other important skills. We also asked the students: What are the most important skills you should have when you graduate?

A very large proportion of UOS students (81%) answered this question, as did nearly half of the CU respondents (41%). The answers provided are presented in the following table (110):

Table 110-students-skills when graduating

Important skills when graduating	UOS student	CU
Critical thinking	21%	9%
Problem solving	35%	56%
Research skills	21%	9%
Engineering knowledge	7%	31%
Know many programming	0	3%
Teams-working	0	3%
Communication	47%	41%
Decision-making	35%	22%
Life long learning skills	7%	22%
Computer skills	0	9%
Knowledge of professional standards	21%	9%
Networking	14%	6%

Important skills when graduating	UOS student	CU
Ethics	14%	0
Visualizing skills	7%	0
Writing skills	7%	0
Library skill	7%	0
Arabic language	7%	0

Here we see some departures in the response profile from the previous question concerning what skills are important in the academic program and which become increasingly important as one progresses through an engineering degree. UOS students highlight critical thinking skills, here, and also research skills, the inclusion of the latter in some contrast with the responses to previous items. Both groups emphasize problem-solving (more so, CU students at 56% vs 35%) and communications skills. Lifelong learning is, once again, more prevalent among responses from CU (but now appears in UOS responses). “Engineering knowledge” is more prevalent among CU students as a response. UOS respondents now mention knowledge of professional standards (21% of respondents vs. 9% from CU, and place more emphasis on decision-making skills. They mention (while CU respondents do not mention) ethics, library skills and writing skills. CU students again mention lifelong learning. See table below.

Of course, non-responsiveness on these items is very high, so “n” is small for each item, and, moreover, to some extent different subsets of the students have answered the various items. Thus, it is dangerous to read too much into any apparent variance across the answers. For example (and there are multiple possible interpretations), it is possible that more of the students who answered the last item, than the previous two, have work experience, which might colour the response in a specific way. Nonetheless, taken together, the results for these last three items give a picture of sorts of what skills students feel are important, and when they come into play most significantly, with just some descriptive differences in emphases across the two groups. When we ask the students: are all the required or important skills mentioned above taught in your classes, and which are the ones that are NOT taught, again over 80% (82%) of UOS students and nearly half (41%) of CU students did not answer. The responses that were obtained are summarized in table 111 below).

Table 111-students-skills not taught in classes

Skills not taught in classes	UOS students	CU students
Yes, there are skills that are not taught	35%	41%
No, there are no skills that are not taught	50%	14%
Decision making	7%	14%
Library skills	7%	3%

Skills not taught in classes	UOS students	CU students
None	7%	17%
Lifelong learning skills	0	3%
All	7%	20%
Knowledge of professional standards	7%	6%
Social networking	0	3%
Writing skills	0	6%
Research skill	0	3%
Critical thinking skills	0	9%
Presentation skills	0	3%

More CU students proportionately, indicated there are skills that are not taught, (41% as compared with 35% from UOS students). However, it is not so clear from the responses which elements are not taught, though decision-making, library skills and lifelong learning received some mention from CU students along with social networking, writing, presentation, research and critical thinking skills and knowledge of professional standards. On the UOS side, a smaller proportion, of a small number of respondents (still, one third) indicated there are skills that are not taught and identified decision-making and library skills and knowledge of professional standards.

We asked the question: “what resources do you use in your courses, in your present year of studies (check all applicable responses)”. A third of CU students and two-thirds of UOS students did not answer this question. Among UOS respondents, 81% say they currently use online resources, 70% use textbooks and 35% use journal articles. Of the CU students who replied, a large majority identified all three sources.

Finally, we included this item in the student survey: “On a scale of1-5 (5: “most important”, and 1: “not important at all”) how important are skills concerning the ability to find, evaluate, store and apply information sources in your field of engineering, in the context of the professional workplace?

Sixty-nine percent of CU students responded to this item. 10 % chose the “not important” side of the scale. 72% chose 4 and 5 (40% and 32%, respectively) while, 27% chose 2 and 3 on the scale (3% and 24%) respectively. Notably, 27% of respondents have placed the importance of these skills, the core of ILS, at the midpoint or below on a scale of importance. Among UOS respondents, nearly one-half (45%) calibrated their importance at the midpoint or below.

CHAPTER FIVE: DISCUSSION

Statement Of The Problem

The main problem this research seeks to address is the low ILS level perceived among engineering students. As previously mentioned, there is a lot of missing information regarding the different elements related to teaching ILS in engineering departments. For example, the most important IL skills are not explicitly identified; although researchers and commentators are increasingly aware that engineering has its own IL skills that shape the discipline, particularly as engineering education specialists begin to address the issue, rather than generalist information sciences specialists, as has been the case historically. Similarly, engineering professors are not sure how to define their role with regard to their involvement in teaching these skills to their students and how to teach these skills. Students, on the other hand, may not fully aware of the importance of ILS in their learning and working journey.

Review of the Methodology

In order to collect the required information to understand the core of the problem and propose a solution, this research directly dealt with engineering professors and engineering students in two universities (Concordia university of Montreal, Canada, and UOS in sharjah of UAE). On-line questionnaires and a focus group for engineering professors, and on-line questionnaires for engineering students were used to collect data. Specific statistical analyses were conducted in order to understand and structure the data collected.

Summary of the Results

Engineering professors. Seventeen professors from different engineering departments in both universities (thirty-four in total) responded to the questionnaires on-line. Eighty eight percent of the respondents are male. Their ages range from their 30s to 60s. Five male professors from Concordia University responded to the focus group meeting (one Professors left shortly), and four male professors from UOS attended the focus group conducted in the Emirates. Professors in both focus groups come from different engineering departments and they all have at least 15 years of academic experience.

Understanding the role of other departments. The results demonstrate that professors in both universities often are not aware of the role of the education department and librarians within the context of teaching these skills. Most of the time, they consult their colleagues, or rely on themselves to solve problems related to teaching, embedding technology in teaching or information usage. They also claim frequently that they have not been contacted by other departments at the university to hold workshops on IL skills for their students in their classes. Professors are generally open to having others come into the classroom for enrichment, but they tend to restrict this practice to the delivery or enhancement of instruction or content concerning specialty engineering topics or aspects of engineering in the professional workplace, including professional standards and ethics.

The role of librarians. Additionally, engineering professors seem largely to believe that librarians do not have a role in engineering classes or with regard to the general development of ILS. The librarians' roles, in their dominant view, is to help students in the library to find the appropriate references for their projects and research. It is a “library-oriented” conception (library skills and/or subject matter expertise of reference librarians) rather than ILS-oriented. Bear in mind we only collected data in two institutions, and it is possible that responses are conditioned by historical relations, activities, and roles in these places. However, the results also fit with findings in the broader literature, as discussed earlier in this dissertation.

The most important ILS in engineering. The majority of the professors (UOS: 58%, Con: 79%) expect students to come to the university with satisfactory developed IL skills (such as communication and computer knowledge skills). Interestingly, UOS Professors mentioned that students lack most of these skills when they start university due to the different high school systems that are available in the region. Such diverse educational systems affect the IL skills that students need to start university. Accordingly, UOS professors urge UOS to adapt different acceptance standards to the university. This is only one possible response, of course, and it is notable that faculty gravitate to a solution with admissions standards, rather than a solution that addresses the gap once students are accepted into programs.

The majority of UOS Professors expect students to have communication skills, information searching skills, or computer and software usage skills when they start their classes. Meanwhile, the majority of Concordia Professors expect students to have pre-requite skills that are related to the class, and communication skills. Not surprisingly, it seems that both groups focus on what is lacking or limited in their audiences, when asked what capabilities of competencies they expect to see in students who arrive in their classes.

Professors also want students to acquire important professional and work-related skills by the time they finish their classes, including other skills such as problem-solving, effective collaboration or team-work, communication and critical-thinking skills. According to Concordia professors, they do not really teach these skills explicitly; however, they still expect students to acquire these skills during their courses, especially that most of these skills are embedded as part of the course outcome.

The majority of UOS Professors also expect the graduate students to acquire the engineering related material and problem-solving skills. Meanwhile, Concordia professors expect students to have, when they graduate, a larger variety of skills such as, writing skills, long-life learning skills, research skills, professionalism, technical skills, presentation and management skills

According to the professors, there are important skills that engineering students must have in order to succeed during their studying periods, such as, the ability to access information (80%), research skills (60%), knowledge of software (85%), writing skills (73%), library skills (only for Concordia Professors: 60%), visual skills (73%), communication skills (UOS:65%, Con: 94%), networking skills (73%), problem solving skills (100%), critical thinking skills (100%), decision making skills (93%), professional standards skills (93%), ethics (100%).

On the other hand, half of the UOS professoriate who responded did not answer if the skills that are needed in engineering are specific to the field or can be viewed as wholly general or generic. Those professors who answered highlighted that the engineering discipline needs two sets of skills: the theory-based skills such as math, and other practical skills such as communication skills. Professors further highlight that these theoretical skills can differ from one engineering department to another. For example, the skills and knowledge for architecture are different than those needed in civil engineering. In architectural engineering drawing skills are very important, whereas in civil engineering, management skills are highly valued. The general theory constitutes the bulk of the curriculum, at the start of their programs. Accordingly, students in the first two years of their engineering studying have a low level of IL skills and this is due to the very intense (and content-intensive) curriculum. During these two years, students need to focus on theory-based materials. Meanwhile, they will be able to apply more ILS in the third and fourth year, especially through doing the Capstone project that culminates the Concordia programs. Concordia Professors highlighted the importance of the Capstone project that engineering students need to prepare for graduating and for which they spend eight months working with their peers, and interacting with their supervisors. Seemingly, the supervisor becomes the main source of ILS training for graduate students. This belief is what makes the majority of the professors think that students graduate with a satisfactory level of ILS, although, for them, evaluating the ILS level is a “critical” and difficult issue. However, the majority of the professors *responding* believe that they can evaluate students’ ILS level through assignments, projects, and case studies. The caveat here is that this is the predominant position among faculty who responded to the relevant questions. However, non-response rate was high for many of these items, so the question whether faculty overall generally hold this position by any wide margin is unanswered.

On the other hand, professors agree that not obtaining the required ILS can have negative impacts on graduated students, given that it can cost them, or their organizations, resources, time, and money. In addition, half of Concordia professors believe that it would lead to low standards in engineering, and more than half of Concordia professors who responded believe that individuals would not be able to progress professionally.

Furthermore, more than half of the professors believe that previous levels of formal education, previous university courses and the activities within the engineering program are significant sources of ILS for students. Also the majority of Professors believe that courses and assignments including projects and team working are the best way to develop students' ILS. Of course, interestingly, faculty also generally admit they do not who how to address the development of these skills explicitly from a pedagogical (course design) perspective. It appears the idea is largely that such skills will be acquired as they are required of the student and as they are modeled by peers and faculty within activities such the Capstone project.

What are the representative examples of ILS in different settings? A high percentage of participants could not answer this questions (70%). However, for the majority of the UOS professors who responded, the most-cited representative example of ILS in engineering is when engineers search for any changes in standards. UOS professors also believe that the ILS representative examples in the academic programs are: developing life long learning skills, and acquiring competence in teamwork. In addition, they believe that the engineers' attempts to solve new problems represent ILS as it figures in the professional practice.

The majority of Concordia professors believe that projects, programming and software applications are the ILS representative examples in engineering. This is clearly an "information technology" centric interpretation of ILS. Related assignments are the

ILS examples in the academic programs, but programming, and team work are the ILS mentioned with regard to the professional practice.

Half of UOS and Concordia professors believe that students acquire ILS in university by studying and through course materials. The majority of both UOS and Concordia professors believe that these skills are critical, and can be evaluated through students' work. The majority of the professors believe that engineering professors should teach ILS in the context of the engineering content or curriculum.

The majority of the professors in both universities believe they communicate the necessary skills at the beginning of the course with their students, and identify clearly through the syllabus the required skills during the semester. However, more Concordia professors than UOS professors use other teaching tools such as videotapes and case studies, although the majority of the professors believe using textbooks only is a less difficult way to teach.

The majority of professors from both universities explain that they do not include any specific activities to teach ILS, but they give groups assignments and projects to ensure students acquire these skills.

Professors from both universities did not demonstrate a deep understanding of the meaning of ILS, neither are they aware, generally, of any position taken by any authorities regarding promoting ILS in engineering. Additionally, the majority of the professors in both universities had not read any materials on ILS, although they believe they possess many ILS. Nevertheless, they mentioned that they have acquired these skills on their own through study, work, and experience.

Engineering students. The majority of the UOS students are males and are in their twenties. They have minimum work experience, and come from different undergraduate engineering departments. Meanwhile the majority of the Concordia students are also typically in their twenties (60%), come from a variety of engineering departments and from both undergraduate and graduates programs including PhD and Master. In addition, the majority is male, with different working experience, mostly related to engineering.

However, the majority of the students from both universities fail to give an acceptable definition of ILS. Additionally, they know about ILS through this survey. However, the majority understands the importance of some of these skills for their success either during their studying or working, such as, problem solving skills, communication skills, and critical thinking skills.

Interestingly, more Concordia students, than UOS students, are aware of the skills that are needed to start university, particularly with respect to ILS and independent learning skills. The majority of the students in both universities believe that most of the ILS are not taught in the engineering program.

On the other hand, the majority of the students in both universities recognize that there are skills that become more important throughout their studying years such as problem-solving skills, and independent-learning skills for Concordia students. However, the majority of the students highlight problem-solving skills, communication skills, decision-making skills as the most important skills they need when they graduate from the engineering program.

Discussion of the Results

The main goal of this research, as mentioned earlier, is to identify, characterize, and solve the key problems of the engineering students who are purported to graduate with unsatisfactory level of ILS. Accordingly, the opinions of the engineering professors and students have been investigated to understand more fully the different components of the ILS problem in higher education in the engineering departments. We believe that the case study approach that we used can highlight the main problems associate with teaching ILS in engineering departments. In the following section, we will discuss the main findings, and the key issues.

The literature review does not offer a complete picture of ILS in engineering in HE settings. More specifically:

1. We do not know what are the IL skills that are specifically required in engineering.
2. We do not know what the opinion and positions of engineering professors are towards the whole issue of ILS, or how they teach these skills.
3. We do not know what engineering students think about ILS.

What the literature review shows is that:

1. There is a large percentage of engineering graduate students who do not have a satisfactory level of ILS which affects their work performance and their life long learning journey.
2. Engineering professors have negative attitudes towards librarians.
3. Librarians take the responsibility of teaching ILS, mainly in one session.

4. There are certain ILS skills for engineers that they must learn and know.
5. The accreditation societies urge for these skills to be as part of the outcome or educational programs, but detailed, specific descriptions or operationalization of these skills, and guidance concerning how to teach or develop them, are lacking

Accordingly, this research investigated the following related issues to complete the picture regarding the situation of ILS in engineering in HE:

1. What are professors' abilities to deal with ILS
2. What are these skills before, during and after graduating from the engineering programs
3. How do students understand ILS.

1. Professors' positions:

We hypothesized that engineering professors do not necessarily have a deep understanding of information literacy skills. Accordingly, they may lack some of these needed skills, and even when acquiring these skills they do not master the techniques to teach these skills to the students. Therefore, we asked a few questions to clarify these issues, such as what is meant by ILS? How did they acquire these skills themselves? Have they read any materials about ILS? Did they receive any teaching or research training? We also asked the professors about their teaching styles and their role in teaching ILS.

We also anticipated that professors are not aware of the roles of other departments in universities, especially librarians. Professors also do not ask librarians or pedagogical specialists to help them teach their students. Such departments might have a role in teaching ILS to students.

2. The needed skills in engineering:

We considered the possibility that certain skills are needed at different junctures in a students' path (e.g, outset, mid-program, post-graduation) We also asked professors what are the most important channels that students can use to learn ILS, and who should teach ILS to engineering students.

3. The students' positions towards ILS. We asked students to describe their understanding of ILS and what are the most important skills they believe they need to succeed while studying and working, since we hypothesized that engineering students may not be aware of the needed ILS in engineering and, further, that they may not know how to gain these skills, even if they are aware of them.

The following pages describe how the participants responded and how their answers can help answering our research questions. We divided the answers to the questionnaires into the following sections: engineering professors, engineering skills, and engineering students.

Engineering Professors:

Librarians and other departments' roles. The greater percentage of professors from both universities reflects the belief that librarians have no role in their classes. In their opinions, the librarians' role is restricted to the library and is related to guiding students to find the appropriate resources, such as books and other publications, for their assignments or projects. However, Concordia professors in the focus group talked about a librarian who was always helping engineering students with their assignments, research projects, and capstone projects, as well as always being available to host workshops for students. Furthermore, they mentioned that the workshops that the librarian hosted for engineering students, which they believe are important for students' success. It is also important to mention once more that the participants in the focus group at Concordia University formed a special group since we had one chair, and two professors who had previously been chairs. In other words, these participants were fully aware of the different workshops that library offered, and the important role librarians try to play to teach ILS to the students in general and more specifically to engineering students. They were, in fact, fully aware of the new standards that have been proposed by the accreditation body, that incorporate IL related skills. However, the participants' answers to the questionnaires did not reflect that they were aware of the librarians' roles in teaching or helping students outside of the library. On the other hand, the participants in the UOS focus group believe that librarians do not have any role in their classes, and they cannot offer any help to the students other than guiding them to the appropriate reading materials. One of the professors expressed the view that librarians really have no role at the university level; he believes that librarians may play a role in high school but not in university. The UOS participants in the focus group were actually surprised to be asked about the role of librarians in teaching students. Similarly, the professors in both universities who responded to the questionnaires explained that they did not receive any invitation to host a workshop in their classes. They preferred to host guest speakers coming from industries to talk about the different engineering technical issues including ethics, management skills, or communication skills.

Engineering professors in both universities are also not aware of the roles that other departments or centers within the universities have in teaching, using technology while teaching or using information in teaching. Engineering professors prefer to solve any related problem to teaching or embedding technology within their teaching or using information in teaching themselves, or they might ask a colleague.

In summary, engineering professors (in North America and in Middle East) believe that there is no role for librarians in their classes. Librarians can only help students guiding them to the materials sources for their topics. Such a result would support what other authors conclude about the poor relationship between engineering professors and librarians. According to these authors, engineering professors might not take librarians seriously for different reasons. One of these reasons is simply that librarians do not have graduate degrees, necessarily, a second is that they do not have engineering qualifications.

Reinforcing the literature, the current research clearly demonstrates a lack of communication and collaboration between librarians and engineering professors. In fact, the most convincing piece of evidence that engineering professors are not aware of the different roles librarians can play in their classes is the traditional role of book-keepers that is associated with librarians. Furthermore, a small group of professors in UOS cannot foresee any role for librarians within universities. In other words, librarian should not be found in higher education settings but rather in primary and secondary education settings. What does this imply or suggest about librarians working in Middle East cultures? This observation warrants further investigation in order to establish if, and why librarians in

Middle Eastern societies may not necessarily have a recognized role in higher education settings.

Suggestions. Engineering professors need to understand the different roles that other departments and centers can play, including libraries, and the importance of workshops they offer for students and faculties. Departments or programs should encourage professors to attend these workshops, as well any engineering organizations and associations. These organizations should offer ILS workshops that are related to engineering topics during conferences. In addition, to help overcome this problem, universities should have specialized librarians trained to help specifically engineering students. Such a person should have the knowledge of engineering topics and the skills that students and professors need in order to succeed, and, in addition, some knowledge and skills regarding learning and pedagogy and familiarity with engineering curricula.

Professors' understanding of ILS: This research hypothesized it was possible that engineering Professors do not fully comprehend the meaning of ILS, do not master some skills of IL, or do not master the techniques for teaching these skills. Accordingly, we asked them what is meant by ILS, how they obtain these skills, and how they evaluate their ILS' level, as well as other questions about their teaching styles including efforts and techniques used to teach ILS.

Almost half of the professors in both universities did not answer the question regarding the definition of ILS which (by inference) supports the contention that knowledge or awareness of ILS skills may indeed be restricted. The majority of the UOS professors who answered mentioned that ILS represents searching for information, or they provide a definition that is very close to the one on the ALA's website. Interestingly, the Concordia professors who answered provided different definitions, such as: ILS is computer knowledge, or ILS is meant to collect relevant info to solve a problem. In the same vein, the Concordia professors referred to ILS as the “sub skills” that are needed as part of engineering study.

However, they do not directly teach these skills. They often tied these “sub” skills to communications skills including presentations, writing skills, and so forth. Since half of the professors in both universities did not answer this question, and the majority of those who responded failed to give an appropriate definition (except the few UOS professors who could provide acceptable definitions similar to the ALA’s definition), we concluded that engineering professors do not fully comprehend the meaning of ILS. We hypothesized that engineering professors lack an in-depth comprehension of the meaning of ILS. The majority of their definitions do not meet, at least, the ALA’s definition. For example, a few professors equated ILS with computer knowledge; others saw ILS as searching for information. Such a “limited” and “superficial” definition – one which equates ILS largely with information technology and search -- does not help engineering students gain all the required IL skills in engineering such as communication skills, or problem-solving skills. since their professors are not aware of the importance of the other IL skills. Therefore, it is the responsibility of the management of the university, of engineering associations (not least, the accrediting bodies for engineering education, such as CEAB) and possibly even employers of engineering professionals, to promote awareness and, further, advocate for appropriate guidelines.

Beyond awareness, there is a need to acquire more knowledge – to identify and develop, through research and evaluation, what are best, “good” or “evidence-based” practices. Programs, and those working in the field researching engineering education, need to play a role here. While it is laudatory that CEAB, for example, has included objectives related to life-long learning and ILS in their requirements of accredited programs, what is missing is specific concrete guidance concerning how this can be accomplished effectively and efficiently, while still retaining full coverage of the remainder of a curriculum that is heavy with engineering theory, application and practice. The engineering organizations such as CEAB in Canada and ABET in the US can play a very important role in introducing engineer professors to these skills through workshops in conferences, or meetings, or through publications.

Librarians can play a role, also, but in order to be effective, engineering professors need to appreciate the role they can play and librarians need to respond by tailoring their efforts more closely to engineering students' requirements. Again, good practices, such as those encapsulated in successful interventions, need to be broadly shared and communicated, and here librarians and their associated associations and societies could play a significant role. They should also be open to conducting research and evaluation with engineering programs and with engineering education researchers.

Beyond simple "level-one" evaluations that focus on participant reactions, what is needed is evaluation and research practices that identify what really leads to competence in the appropriate areas. This may require more "involved" models of engagement for research and evaluation, as alluded to in the Introduction and Methods chapter of this dissertation, such as action research and design-based research. Action research is particularly appropriate for settings in which entrenched attitudes or perspectives need to be tackled and evolved. Design-based research is best suited for situations where an artifact, such as a program or course, needs to be improved through an iterative approach that leverages concepts, design principles, and knowledge from various sources. Recently, researchers have begun to call for new methodologies in engineering education research, both to improve the quality of evidence acquired, and also to broaden the range of questions that can be tackled effectively (cf. Case & Light, 2013).

All of this needs to be accomplished against the general backdrop, which is the prevailing attitude that ILS are not specifically the responsibility of higher education, and the belief that such skills and competencies can always be acquired simply by osmosis, or through interactions with technology outside the sphere of education, or as a result of their necessity within the context of assignments with other explicit objectives. These attitudes and beliefs need to be challenged directly, with evidence. It bears noting that the same attitudes prevailed in the past with respect to basic skills such as writing, listening comprehension and communications. Today, compared with 20 years past, universities have relatively stringent requirements and standardized testing methods to evaluate these skills, along with, usually, a comprehensive support system in terms of non-credit and credit support for academic writing and communications through service courses and workshop.

All the professors from both universities agree, that the information revolution has a profound impact on engineering. But, 87% of professors from both universities admitted that they did not read any materials on ILS. In addition, the majority of UOS professors declared that they obtain ILS themselves through self-learning; a small minority admitted that university studies, including seminars and workshops, provided them with their knowledge of ILS. Only slightly more encouraging were the responses from Concordia professors who declared that they obtain ILS either through workshops and seminars or through working, knowing that 41% did not answer how they develop these skills themselves. The majority of both UOS and Concordia professors believe they have very strong ILS, themselves. These results underline the need to educate the engineering professors about the different issues related to ILS especially those are needed in engineering field.

Of particular interest is the fact that almost half of UOS professors and more than half of Concordia professors are not aware of any position taken by their respective professional accreditation bodies regarding ILS status in engineering. Nonetheless, a few professors highlighted the importance of communication skills and an even smaller number mentioned the CEAB's position on ILS and its "recommendations".

Teaching style. The majority of the professors in both universities – about 60% -- would include guidelines and instructions about how to write a midterm papers, but 40% of the professors from both universities make the assumption that students already know how to write these types of paper. Interestingly, more UOS professors provide detailed feedback to students on their writing technique. No doubt, this is a reflection of their respective linguistic contexts.

Such a result supports the previous conclusion that engineering professors solve any educational problem they encounter themselves. In this respect, they are hardly unlike other higher education instructors. In this sense, they explain the details for the midterm papers and provide detailed feedback (more UOS professors) on the assignments. Meanwhile a small percentage of UOS (7%) and half of Concordia professors would direct students to seek help outside the department but within the university. With regard to students acquiring other skills that are not directly taught in the classroom, a significantly bigger number of UOS than Concordia participants would encourage students. This could potentially be attributed to the fact that UAE has to deal with various high school systems. This issue and its impact on ILS in higher education settings were clearly highlighted by UOS professors during the focus group. However, 28% of UOS ask students to obtain English language skills comparing to 21% of Concordia professors who ask students to seek communication, programming, or software usage skills.

On the other hand, the majority of professors, roughly ninety percent from both locations, believe they inform students of the required skills at the beginning of a semester through the course outline. An additional step, which would have supplemented the data collection in this study, would have been to request and analyze course descriptions and evaluation rubrics from participants, but this step was not included. However, more Concordia professors (67%) than UOS professors (27%) used different teaching resources (other than the textbooks) such as videotapes, field trips, research papers, and so forth to transfer these skills to their students. The high percentage of UOS professors who mainly use textbooks, do not consider textbooks insufficient as a basis for teaching engineering materials. Does that mean that engineering professors in UOS need more training on how to teach these skills using different media? Are these professors aware of the powerful instruments and sources that can be used to teach aside from textbooks or how to integrate them into curricula? These questions need to be further explored.

How do engineering professors teach ILS? Nearly half (41%) of professors in both universities did not indicate whether they incorporate any specific activities to develop ILS in their own classes, but believe that their role in teaching ILS is covered or accomplished through giving assignments and projects. This leads to the question as to whether they know how to incorporate such activities? However, the majority of UOS professors believe that giving out assignments, projects, and case studies is enough for students to acquire ILS. In addition, Concordia professors also ask their students to do presentations. The high percentage of professors who did not respond clearly highlights the fact that professors lack the knowledge about teaching ILS. This result also suggest, perhaps, that these skills are not emphasized enough by CEAB, to be included in the curriculum. The fact is that, to this date, ILS are considered by CEAB as courses outcomes, but so far, there is no concrete example regarding which skills should be taught and how they should be taught—a problem that Concordia professors highlighted during the focus group. Furthermore, these professors declarted that, within two years, CEAB's plan for ILS to be a mandatory part of the program outcome, not just as a recommendation. In other words, engineering professors are unsure regarding their role in teaching ILS. To solve this issue, specific skills need to be identified and appropriately contextualized in order to help engineering professor include them within their classroom.

ILS in engineering. What skills do students need before starting their engineering classes? Over a third of professors from both universities prefer that students have good communication skills. In addition, nearly one-third of UOS Professors would also like students come to classes with advanced English language skills (including writing), and information searching (including researching) skills. Meanwhile, 36% of Concordia Professors would like students to master the pre-requisite skills that are related to specific classes. The UOS professors who participated in the focus group expressed their frustration with regard to the lack of skills students have when they first start in the engineering program (e.g.. English and math skills). Furthermore, most of the students in the following years lack the basic knowledge of the pre-requisite skills that are related to a specific class. As mentioned earlier, the professors attributed this problem to the different educational systems found in UAE and their efficacy in preparing students for university-level studies, and the degree to which their outcomes are similar or standard. Although students graduate from high school with high a GPA, they do not all have the same knowledge base. The UOS professors in the focus group suggested that the administration in UOS should screen students who apply to engineering using specific tests that target these skills (specifically, English and math). A TOEFEL score is required of UOS applicants. Possibly, the level is set too low, or else a better test would be one which incorporates English for academic purposes with specific focus on the requirements for the study of engineering, or, possibly the university should implement a better program to support development of English for academic purposes. These issues are only tangential to our focus here on ILS.

The majority of the professors (UOS: 64%, Con: 50%) would like students to master all the course related skills when finishing their classes. But more Concordia professors (44%) than UOS professors (14%) would like students to have communication skills when finishing the classes. Moreover, Concordia professors in the focus group highlighted the importance of communication skills as an outcome of the course although they do not teach them explicitly. They just expect students to pick-up these skills through course-related activities -- projects, assignments, case studies, and teamwork.

The communication skills are the main skills that Concordia professors ask students to have before starting classes and after finishing their courses. In addition, they want students to acquire the course-related knowledge and skills by the end of the course. Meanwhile, UOS professors mostly prefer for students to master English language skills before starting their course and master the course-related skills when completing the course. This differential result is related to cultural differences, as the English language is not the dominant language spoken in the Middle East. Thus, students struggle with the acquisition of these skills despite having passed the TOFEL exam in order to be accepted in UOS.

In addition, the majority of Concordia professors (80%) compared to a small minority of professors at UOS (8%) believe students should graduate from the engineering program with problem-solving skills. Meanwhile the majority of UOS professors (58%) believe students should graduate with engineering knowledge. The rest of UOS professors (33%) want student to graduate with communication skills comparing to only 17% of Concordia professors. The focus on communication skills reflects an expectation of an outcome during the progression through courses at Concordia, while it is an expectation on program completion at UOS. Again, this is possibly simply a reflection of the linguistic realities in the two settings. A small percentage (25%) of Concordia Professors would like students to acquire technical and professional skills.

Despite these issues, it is important to know what are the most important skills needed in engineering to ensure the success of students. Using a Likert scale we asked participants about ILS component skills (the ILS that this research focuses on) and how they value these skills (on a five-point scale from most important to least important). The results are as follows:

One hundred percent of professors from both universities believe ethics, critical-thinking skills, and problem-solving skills are important for their students' success.

- 90%-80% of all professors believe that professional standards, ability to access and store information skills, and decision making skills are important. Also communication skills for Concordia professors only are important.
- 80%-70% of all professors believe that knowledge of computer skills, visual skills, networking skills are important.
- 70%-60% of all professors believe writing skills and research skills are important for students' success.

With regard to traditional library skills, specifically, only 60% of Concordia professors and 40% of UOS professors see these as important to students' success.

But are IL Skills in engineering simply generic ILS as described in ALA in other frameworks, or do they need to be contextualized and operationalized within the context, problems and practices of engineering? Half of the UOS professors ignored this question as compare to one -quarter of Concordia professors. However, the majority of UOS professors, and half of Concordia professors who answered said ILS are general skills. Possibly, even those responding have given little thought to the degree to which these skills might be contextualized, or the extent to which there are specific example within engineering that differ from those in other fields..

These results must also be seen within the backdrop of the general finding that reflects the lack of knowledge of engineering professors regarding the types of ILS found in engineering. Also, few professors mentioned that they were unsure regarding the status of ILS in engineering (generic or discipline-specific). An even smaller number of professors explained that there are skills that engineering shares with others disciplines (e.g. math and physics), aside from engineering-specific skills (e.g. drawing or visualization skills and problem-solving).

Engineering comprises a knowledge base that includes well-defined subjects such as mathematics (resource allocation, analysis…) but it is also quintessentially a design-oriented field which means that solutions are underdetermined and the field is "ill-structured" overall, an issue that was briefly touched upon in the introductory chapter. Nonetheless, it is evident that engineers should have specific skills that are different from the set of skills that students in medicine, history or finance should have and that engineers use ILS in different setting to achieve different specific objectives. For example, an engineer clearly needs to be familiar with different forums, scientific, and professional databases, journals, than an accountant. They may need, for example, specific knowledge of when and how to do a patent search that would have no utility for someone is, say, history or economics.

Arguably, an engineer should receive a special ILS training that is designed only for engineers, or which introduces all the different and needed IL skills that suit his or her field of experience. Accordingly, offering general ILS courses (for all disciplines) to engineering students would not be as beneficial or effective as offering courses that are specifically designed for engineer students.

There are really two lines of argument here. First, there is the consideration that the skills, or their relative weight or importance, varies from field to field. Engineers may need to keep their knowledge very current against a daunting variety of knowledge bases (patents, materials science, measurement, standards, construction or production methods, project management processes and methods) each of which is rapidly evolving. This may require not only familiarity with different sources and information retrieval tools than are appropriate, say, for a historian, but also perhaps a different set of habits, predispositions and behaviors – a different approach to a different world, or ecology, of information, if you like.

Second, even if one minimizes the specificity of ILS in engineering, we also know that skills and knowledge are best acquired, and most easily transferred (at least, in the sense of near transfer) to operational environments, if they are learned, practiced and evaluated within a setting that is "authentic" or that reflects the environment and circumstances to which the skills an knowledge must transfer. These principles are well-established in the educational research on learning and transfer, and encapsulated in whole traditions and theories such as situated cognition, situated learning, minimalism (Carol, 1984) and, indeed, as far back as Dewey's writings on education and society. It follows that, even if ILS skills are argued to be general, one would expect they would be taught more effectively (from the standpoint of relevancy, engagement and learner motivation), and transfer better, if they were couched in terms of examples, practice and activities specific to the experience – work and study – of engineers.

In addition, these courses should be taught at different levels throughout the engineering curriculum since all professors in both universities strongly believe that students in their 3rd and 4th year are better prepared to acquire some ILS. According to the Concordia professors in the focus group, the first two years of engineering study that characteristically concentrate on theories of math and physics leads to the low ILS level within engineering students in first and second year. Additionally, students in their fourth year should receive more training on ILS specifically in order to ensure the success of their capstone project.

While higher education settings often display the attitude that soft skills or cognitive skills, beyond the specifics of the fields' content-oriented requirements or objectives, can be acquired by the student independently, the small amount of quality research that is extant belies this notion. Perhaps the most significant example of this in the engineering education literature pertains to McMaster University's approach to development of problem-solving skills in engineering. A 25-year project to study effective practices and curriculum innovation is reported by Woods et al (1997). This report describes the evolution of an approach that required four courses, addressing 37 identified skills, which are acquired content–independent and then transferred explicitly to Chemical Engineering content-specific domains, then further generalized. The work required the development of test procedures to assess these skills, both for examination purposes and for ongoing student self-assessment and feedback. Clearly, developing and evaluating such an approach is not a trivial matter, and not an undertaking one would expect could be carried out across engineering education institutions and programs. Instead, there is a need for development and identification of best practices, and their dissemination, as a more efficient, viable, rationale approach. Even here, it must be acknowledged that transfer of best practices and diffusion of such innovations is not a trivial proposition, either. Simply having access to sample curricula, evaluation instruments, and evaluation reports and case studies is not sufficient to ensure effective practice, even where there is significant motivation to adopt and adapt the innovations in question. This is where the contributions of other experts, in education departments and in university service units dedicated to pedagogy and teaching will be critical.

On the other hand, the majority of the professors in both universities believe that students graduate with a satisfactory level of ILS, although a few professors believe that the ILS level is hard to evaluate. This contrasts with the literature, where, as reported in the Introduction and Literature Review Chapters, surveys have raised the perceived problem of low-levels of ILS skills among graduates of science and technology and, specifically, engineering, programs. Most of the professors believe they can evaluate students' ILS level through assignments and projects, though this would appear to involve a "subjective" appraisal, since there is no indication that these courses include explicit objectives and evaluation schemes related to these skills, and since the predominant view recorded from our surveys is that students learn these "incidentally", essentially. Such a result demonstrates that engineering professors are reluctant in evaluating ILS in graduate students. It seems that engineering professors use regular assignments and projects to allow students the opportunity to develop ILS and to evaluate ILS level all at once. Such a result leads to the question whether engineering professors actually use the same assignments and projects for both purposes (with intent) or are there different parts of assignments dedicated to ILS, specifically, by design. In the absence of any analysis of courses, assignments and evaluation methods, it is difficult to draw any firm conclusion. This issue needs further investigation in the future research in order to ascertain how engineering professors using assignments and projects as tools for delivering and evaluating ILS at the same time, to determine the efficient usage of assignments and projects. No doubt this matter could be improved if professors are educated or informed about the different ILS and how to implement them effectively in their classroom. Our results do suggest strongly that faculty simply lack the awareness, knowledge and appropriate tools to teach these skills effectively.

Yet, while faculty seem to lack knowledge concerning the exact nature of ILS and how to promote their development, they clearly understand that these skills, however ill-defined on their part, are critical. On the other hand, it is important to understand the impact of lacking ILS in engineering on different level for different reasons. For example, understanding the importance of ILS in engineering would motivate engineering organizations and educational institutes planning for serious steps in teaching ILS to the engineering students. The impact of low ILS in graduate students, regarding professions, engineering practice and individuals are explored. Half of the professors in both universities did not answer this question, which reflects (again) the professors' reluctance to answer question about ILS knowledge, which can be attributed to their lack of knowedge concerning ILS. Nonetheless, half of UOS professors believe that lacking ILS would cost their professions time and money. Other UOS professors believe that ILS are very important for professionals, engineering practice and individuals. According to the professors in both universities, lacking ILS in engineering practice would lead to bad results, lack of creativity, bad decisions, difficulty in maintaining a good position, and the lack of personal growth. Similarly, the majority of Concordia professors also believe that it would lead to low standards in engineering practice and inability to progress the field.

So according to engineering professors, lacking the ILS could have very negative consequences on engineering practice in general, on the profession, or on organizations or on an individual's life.

Since ILS are crucial to the engineering profession, one must ask when and where students should develop these ILS? The majority of the professors in both universities believe that high school curriculums, activities in engineering programs, and activities in other university level courses are significant sources of ILS for engineering students.

But what is the best way for engineering students to develop ILS? Half of the participants from both universities did not answer this question but the majority of professors who answered in both universities believed that assignments, projects and courses are best way to teach students how to develop ILS. At the same time, many professors in both universities could not identify representative examples of the ILS in engineering programs and practice, since 70% of professors did not answer the related questions. And those professors who answered had very different opinions

How critical these skills in professions? Half of the professors in both universities skipped this questions but the majority of the UOS and Concordia professors who answered believe that these skills are critical to the profession.

The majority of the professors believe that ILS can be delivered through courses that teach ILS only but within the engineering curriculum, or integrate ILS teaching materials within each of engineering topics. Very few professors would prefer that the librarians teach these skills or provide independent ILS courses.

The majority of UOS professors believe that special educators should teach ILS material to engineering students, less believe that engineering professors should teach these materials. Meanwhile, the majority of Concordia professors believe that engineering professors should teach these skills (70%) and less Concordia professors believe that special educators should teach these skills.

Seventy percent of UOS professors and 50% of Concordia professors did not answer if there are any obstacles in teaching ILS, but the majority of the rest of UOS professors explained that there is a resistance to change; meanwhile the majority of Concordia professors believe that the curriculum is full, leaving no obvious place to incorporate further content or skills. This observation regarding the pressures on the curriculum would seem to suggest that the only feasible solution may be greater integration with existing courses through the types of assignment required, and the evaluation methods used. But this approach is perhaps the most difficult given the degree of curriculum reform and adjustment required, and the specialist knowledge regarding instruction, evaluation and curriculum design that would have to brought to bear in completing the exercise.

Sixty percent of professors from both universities did not answer regarding the changes that need to be done, but the majority of UOS believe in integrating ILS with engineering subjects, and improving reading and research skills. For Concordia professors especially, there is a preference for changing the structure of the courses and integrating ILS within the engineering subjects.

The Engineering Students:

There are some difference between the engineering students groups who participated in UOS and Concordia students. The UOS students are mostly in their 20s, and 80% are males, they generally do not have any work experience in engineering, and all of them are in undergraduate programs. There is a greater diversity within the Concordia engineering students who responded to our survey: their age ranged between 20 and 40, they are undergraduate, PhD students or master students, and most of them have some engineering working experience. Such a difference is due to the social and economic status in the UAE, where students more often are supported financially by their families during their program of studies. Students do not have to work to support themselves; they are also studying at young age, since the idea of going back to university is not a common idea in the Middle East and most university students come directly from high school.

Do engineering students fully understand the meaning of ILS. The students' answers suggest this is not the case since 82% of UOS students, compared to half of Concordia students, did not give a definition of ILS. Further, half of the UOS students who answered, compared with 42% of Concordia students, responded: "I do not know", The majority of the students who responded gave a definition closer to the one given by the ALA, which was clearly, it appears, taken from the Internet. In addition, 62% of UOS students, compared to 40% of Concordia students, did not provide an answer for the question: where did you first hear about ILS? The majority of students said that they first heard about ILS in this survey, a smaller number of students said they heard about ILS from courses and an even smaller number of students heard it from the internet. Such a result reflects that students need to be educated about ILS, and need to know more about these skills.

But are students aware of the importance of ILS in their engineering studies? Asking the participants, more than half of UOS students did not answer this question, comparing to 31% of Concordia students. These were their answers:

- Access, store, and use information: more than half of the students believe they are important skills
- Research skills: half of UOS students comparing to 60% at Concordia, see these as important
- Knowledge of applications for info usage: Half of the UOS students believe they are important, but 60% of Concordia students have a neutral attitude
- Writing skills: half of students believe they are important, and less respond neutrally
- Library skills: Students are divided between its important, neutral or not important.
- Visual skills: half of the students believe they are important and a smaller proportion are neutral
- Communication skills: the majority of UOS believe they are important as well as half of Concordia students; less Concordia students are neutral
- Social networking: half of UOS students believe they are important skills and less are neutral, but less than half of Concordia students believe they are important and the rest are divided between neutral and not important
- Problem solving: the majority of both students they are important
- Critical thinking skills: the majority believe they are important

- Decision making skills: half of UOS students comparing to 77% of Concordia students believe they important, less of UOS respondents are neutral
- Knowledge of professional standards: half of UOS students comparing to 67% of Concordia believe they are important.
- Ethics: the majority of students in both locations believe they are important

These results demonstrate that students in both universities generally do not value much the above-mentioned skills in their studies. However, a somewhat bigger percentage of Concordia students value these skills. This may be in part a result of the different pedagogical practices within the two institutions, with UOS professors depending more heavily on textbooks to deliver the curriculum. It is, of course, also possible that these results reflect broader cultural differences concerning the usage of information and the internet. Further investigations would be required to disentangle and identify the contributing factors here. However, a solution could be to develop more awareness training or education within the institution, delivered either through the faculty or through the participation of employers or professional associations. Given attitudes towards library services within the UOS group it is not likely that library-delivered instruction or communications would be an ideal solution. It would also be interesting to see whether there are any differences across the two locations in terms of expectations within workplace settings.

Similarly, we asked students to value the following skills for engineering *practice*:

- Research skills: half of both groups believe they are important and the rest are divided between neutral and not important
- Knowledge of applications for info access and manipulation: half of both groups believe they are important and the rest are divided between natural and not important
- Writing skills: half of UOS believe are important and the rest divided between neutral and not important, but 43% of Concordia students believe they are important and less believe they are not important
- Library skills: the majority believes they are not important.
- Visual skills: half of UOS believe they are important compared to the majority of Concordia students believe they are important
- Communication skills: the majority of both students believe they are important, the rest are largely neutral
- Social networking skills: the majority of both groups believe they are important.
- Problem solving skills: a big majority (71% and 89%) believe they are important
- Critical-thinking: 67% of UOS comparing to 87% of Concordia students believe they are important
- Decision-making: 68% of UOS comparing to 81% of Concordia believe they are important
- Knowledge of professional standards: 70% of UOS comparing to 80% of Concordia believe they are important
- Ethics: 65% of UOS comparing to 75% of Concordia students believe they are important.

The above results show that students understand the importance of certain skills in engineering practice such as problem-solving skills, decision-making skills, knowledge of professional standards skills and ethics. These skills are the same skills that engineering professors also identify. Similarly, the majority of the students believe that communication and social networking skills are important to the students. However, the answers show that engineering students are more aware of the importance of the skills for the engineering practice than within the context of their studies (especially for the UOS students). Such a result supports the previous recommendations regarding the importance of educating the students about the importance of the IL skills to their study. But, more importantly, it is also at least suggestive of the possibility that the skills are simply not sufficiently integrated into the activities and requirements of their academic studies. If students are not saying they are really critical to their studies, it is very likely that this is simply true.

Seventy-seven percent of UOS students comparing to 44% of Concordia students did not answer questions about the skill set required to start university, nor if the important skills change from one academic year to another, nor what are the most important skills they should have when graduating, nor if the above-mentioned skills are taught in their classes. Such a big percentage of UOS students who did not answer such important questions reflect students' poor awareness of their learning journey. Could that be a result of lacking motivation? Or lacking understanding that their commitment to their education is more than attending classes and handing in assignments? Perhaps the issue here goes beyond the specifics of ILS to the larger issue of the culture of higher education and students perspectives on their learning and education. We would do well to consider that discussions of ILS and related challenges have to be situated against this wider backdrop which colors student attitudes, behaviors and dispositions. Conceptually, as well, the notions of what it means to have ILS, and what it means to be "educated" are not unrelated.

However, half of the UOS students who answered identified communication skills as skills needed to start university. A smaller number of students highlighted basic reading and writing skills. Only a third of Concordia students (28%) chose reading and writing or research skills, or communication skills. Similarly, 77% of UOS students compared to 44% of Concordia students did not answer if the important needed skills change from one year to another throughout the engineering curriculum. However, the majority of UOS students answered "yes", and a few students identified communication skills or problem-solving skills. Meanwhile Concordia students chose a wide variety of skills including research skills, communication, or decision-making skills, among others.

Over 80% of UOS students compared to 41% of Concordia students chose not to answer what are the most important skills they should have when graduating. Clearly, UOS students do not have an answer. But the majority of UOS students responding highlighted the communication skills, while others chose problem-solving or decision-making skills, or the knowledge of professional standards. Meanwhile, the majority of Concordia students chose problem-solving skills, and a lesser number chose communication skills, problem-solving, or decision-making skills. A similar proportion (82% of UOS students compared to 41% of Concordia students did not answer if all the above-mentioned skills are taught in their programs, half of the rest of UOS students said "no", but the majority (41%) of Concordia said "yes".

For the learning resources that are used in the classes, 67% of UOS students compared to 33% of Concordia did not answer but the majority (81%) of the UOS students who answered, indicated they use online resources and textbooks, while a small minority mentioned journal articles. Meanwhile the majority of Concordia students highlighted journal articles, and on-line resources as the main resources used in their classes.

Clearly, the use of different resources has implications for the requirement to use ILS in the academic context. No doubt, a curriculum that is based heavily on textbooks as a central resource will have a limiting effect. Yet, moving away from textbooks, particularly in junior courses, may pose challenges for both students and instructors.

CHAPTER SIX: CONCLUSION

In summary, the main finding is that engineering professors in both universities lack a deep comprehension of different elements that are related to the information literacy skills (ILS) including the definition, how to teach these skills and what skills to teach. At the same time, students have very limited conceptions (often no conception) of ILS and to the extent they recognize them, small belief that they are required of them in their studies, though some recognition they are important to professionals.

Faculty indicate they have had little exposure to literature concerning ILS and generally view acquisition of ILS as something that occurs through independent activity and learning, or via the requirements placed on students by certain assignments, and through interaction with peers and supervisors, although there is generally no attempt to measure outcomes or state objectives specifically tied to ILS. Given this main finding, which comes from the responses of participants, and from a high-level of non-response for related items, the study does not contribute as much as one might hope in terms of approaches to developing ILS or detailed conceptions of ILS held by faculty or students.

This is not surprising, in many regards. As discussed previously, there is some reluctance to even view ILS as within the purview of higher education, an attitude that is clearly changing; the literature of the last two to three years includes an increasing number of articles that address ILS in engineering education and across higher education, and some of these come from within disciplines rather that from the library science journals and publications. As remarked before, it is not that long ago that improving academic English was not considered the domain of higher education institutions and programs, but it is really a small industry, today, and a visible part of the service side of academic programs.

At the same time, the lack of agreed definitions and evolving, disputed standards, mentioned in the Literature Review chapter, mitigates against wider acknowledgement of ILS and finding solutions. Without established rubrics and evaluation instruments that can be adapted to classroom teaching, it is also difficult to see how objectives can be formulated and integrated into curricula. Currently, there are various ALR and other rubrics, but these are very general and do not translate easily into course objectives and assignments and rubrics. The interest of accreditation bodies and their expression of related objectives is a step, but until recently these have been very general, conflated with lifelong learning skills, and only “recommended”. In two years, these objectives will be “mandatory” in Canada, but it will certainly be a challenge to respond to this, as members of the Concordia faculty focus group emphasized.

As mentioned earlier, solutions will have to come through improved working relations among disciplinary faculty, librarians, teaching and learning services consultants and educational researchers specializing in engineering education. Engineering associations and employers may play a role, also.

To deal with the problem of generality in ILS skills and objectives definitions, more detailed analyses of the work of professional engineers needs to be undertaken, and perhaps there needs to be closer alignment of curricula with respect to inclusion of “authentic” tasks and assignments. At the extreme, some commentators have argued for a problem-based curriculum for engineering, replacing a textbook-based, “chalk and talk” approach supplemented with a limited project-based component (in e.g., capstone projects) that is more familiar. This is a call for a dramatic revision of curriculum, somewhat analogous to what occurred in medicine twenty-five years ago. Such a drastic change would require the intervention and support of institutions, engineering associations, faculty and accreditation bodies. It would not come about simply by fiat, or wishing it so. Mils and Tregust (2003) address the arguments for problem-based and project-based approaches in engineering education, the differences between them, and some examples and their outcomes.

Despite the apparent benefits of problem-based approaches for encouraging ILS, there is reason for caution. Kirchsner, Sweller and Clark (2004) review the empirical literature concerning various forms of problem-based and experiential learning in an article entitled “Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential and inquiry-based teaching.” Though this was intended largely as an antidote to the many constructivist educational reforms in schooling, the findings apply equally to undergraduate education. The research shows conclusively that these approaches fail, or require extraordinary support for students, and are inefficient unless learners have already acquired sufficient background and prerequisite knowledge including appropriate base schema (Krischner et al, 2004). Constructing a curriculum that integrates ILS through incorporation of increased incorporation of project- and problem-based learning will thus require careful design. Here, again, design-based and action research may play a significant role and there is a need for careful design, deployment and thorough evaluation, of pilot projects.

Here, too, there is a need to consider carefully what the different approaches really amount to. We have mentioned one-shot generalist workshops, full courses delivered by information specialists, workshops developed jointly by faculty and library or information specialists, and "integrated" approaches which weave the learning of ILS throughout the curriculum. But here there is some confusion about what "integration" might mean. In general, in the literature, "integration" simply means interventions interspersed throughout a three or four-year program. For example, Bullard and Eskridge (2011) describe such an integrated approach that comprises three distinct, specific activities, one for each year of a chemical engineering program. In year one, there is a research activity related to a specific chemical process, in year two there is professional development seminar, and in the senior year there is a capstone project. This is distinct from integrating ILS throughout the curriculum, another version of "integration". Similarly, Penn State and other universities have responded to the demand for enhanced design, problem-solving and team skills in engineering graduates by introducing a number of courses that are team-based and project-oriented (Marra, Palmer & Litzinger, 2000). This, of course, is different from instituting a problem-based or project-based curriculum.

Of course, the use of problem-based approaches is also challenging in a context where there is a huge amount of knowledge-based and know-how oriented content to cover, and where this is also evolving quite rapidly in many engineering specialties. It is difficult and time-consuming to develop such a curriculum, difficult to deliver (without professional development of faculty), and difficult to maintain. It also has to be recognized that the challenges facing engineering educators are really enormous, given the realities of the evolving world in which engineers practice as summarized, for example, by Rugarcia, Felder, Woods and Stice (2000). Engineers must adapt to a world of rapid innovation, based on multi-disciplinary technological development, a world preoccupied with environmental issues, a world in which complex intellectual property regimes may complicate processes of innovation, a world in which corporate structures are more participatory, markets (including labor markets) are globalized. Engineering curricula have to respond by including, e.g., aspects of sustainability, patent management, philosophy and history of technology and other topics, in addition to the regular scientific and technical subjects. There are, it is true, many pressures on the curriculum.

From our survey it is clear that faculty are not sure how to teach ILS, and will require assistance through collaborations probably more than professional development, to address this lack. Students had poor conceptions or no conception or ILS in our survey, also, and little recognition that they were addressed in their studies, or were even required for success in their academic programs. That they showed a greater awareness and appreciation for their importance to the professional, practicing engineer, suggests there is a lack within the engineering programs concerned with regard to incorporation of these skills as well as communication or sensitization of students to their role. Many Concordia students had some working experience in engineering contexts and may well have acquired this appreciation from those experiences rather than from information imparted to them through their academic programs.

Finally, there are aspects of ILS that are left out of evaluation tools and rubrics, which typically address knowledge of related concepts and processes, and familiarity with relevant tools and technology. To some degree, ILS has to be considered also as a set of predispositions and beliefs – concerning the necessity and responsibility to evaluate information carefully, use it ethically and productively. These are not just “behaviors” or skills but competencies that incorporate attitudinal components or values, as well. It may be that ILS research could benefit from the incorporation of models such as Perry's model of student development, within longitudinal studies that examine development of ILS skills in higher education settings, and the relationship with other dimensions of a student's evolution and maturation through their education. The use of the Perry model is well-established in engineering education research. Mara et al, referenced earlier for their work at Penn State evaluating the effects of the introduction of problem-based teaching, used the Perry model for a cross-sectional and longitudinal evaluation study. Similarly, Pavelich and Moore (1994) used the Perry model to measure the effects of experiential education in engineering.

RECOMMENDATIONS

In summary, the results of our survey, which are consistent with other findings in the literature, but which offer an even more dire portrait of the situation with regard to understanding of ILS and integration of ILS into engineering studies, suggest:

1. There is a need for standardization of ILS skills frameworks, and the translation of ILS into specific competencies that are contextualized within engineering, and even within engineering specialties.
2. There is a need for pilot studies to evaluate carefully the effects of different interventions to improve ILS. These should be based on common, standardized evaluation tools
3. We need studies that show more clearly what faculty currently do that is expected to improve ILS. These should be based not only on surveys, but on observation of

classroom practices and activities and analyses of documentation such as assignment, tests and course syllabi.

4. If accrediting bodies are to make ILS-related skills mandatory, they must provide guidance in terms of curriculum (content, evaluation, delivery strategies).
5. There is little or no research – no pilot studies – that addresses the more complex solution which integrates ILS across the curriculum by changing pedagogy, including assignments, to require more fluency in ILS. While this may not be the solution (medical school may be a poor analogy or model for engineering education) the approach is discussed but never tested.
6. Studies of ILS development should be longitudinal and should address attitudes and dispositions as much as knowledge and know-how
7. Arguments over which definition or framework is preferable, and whether narrow or broad definitions are to be preferred, are largely pointless. Definitions are good or poor to the extent they serve specific purposes. ILS is a construct, not a metaphysical entity. What is required are detailed studies of how ILS skills present themselves in different contexts (both educational and in the professional practice of working engineers in different roles and within different specialties). These studies should be variously phenomenographic, anthropological and observational in nature. They should also involve “harder” measures of performance and development and not merely subjective perceptions or self-assessments. The results of such studies should guide how we define ILS and broach the question of their treatment within engineering education, primarily, rather than notional concepts put forward by information or education generalists.

8. The relations among different specialists and professionals need to be improved and strengthened in order to bring to bear the kinds of collaborations that will be required to improve ILS skills. The participation of educational institutions and programs, educational researchers and evaluation experts, professionals working in teaching and learning service departments in universities, accrediting bodies, professional associations, and employers needs to occur.

REFERENCES

Ali, R., Abu-Hassan, N., Daud, M. Y. M., & Jusoff, K. (2010). Information Literacy Skills of Engineering Students. *International Journal*, *5*.

Anderson, J. R.; Reder, L. M., & Simon, H. A. (1996). Situated Learning and Education. *Educational Researcher*, 25(4), 5-11.

Anderson, T., & Kanuka, H. (2003). *E-research: Methods, Strategies, and Issues*. USA: Pearson Education, Inc.

Andretta, S. (2005). *Information Literacy: A Practitioner's Guide*. UK: Chandos Publishing.

Asbury, J. E. (1995). Overview of Focus Group Research. *Qualitative Health Research*, 5(4), 414-420.

Aydelott, K. (2007). Using the ACRL Information Literacy Competency Standards for Science and Engineering / Technology to Develop a Modular Critical-Thinking-Based Information Literacy Tutorial. *Science & Technology Libraries*, 27(4), 19-42.

Baldwin, V. A. (2004, June). The Work and Goals of the STS Task Force on Information Literacy for Science and Technology. In *Library Conference Presentations and Speeches* (p. 12).

Baratte, M.; Chong, A., & Foster, J.A. (2011). The Research Studio: Integrating Information Literacy into a First Year Engineering Science Course. *American Society for Engineering Education*, session AC 2011-1407, retrieved at: http://search.asee.org/search/fetch?url=file%3A%2F%2Flocalhost%2FE%3A%2Fsearch

%2Fconference%2FAC2011%2FASEE_AC2011_1407.pdf&index=conference_papers&space=129746797203605791716676178&type=application%2Fpdf&charset=

Berman, E., Baruzzi, A., Bogucka, R., MacAlpine, B., Sparks, O., & Sapp-Nelson, M. (2011). Report on the 5-Year Review of the Information Literacy Standards for Science and Engineering/Technology.

Bolitho, C., & O'Luanaigh, N. (2012). Where do Engineering Students Really Get their Information? Using Reference List Analysis to Improve Information Literacy Programs. AAEE 2012 conference, Melbourne Australia. *Australasian Association for Engineering Education.* Retrieved at: http://www.aaee.com.au/conferences/2012/documents/abstracts/aaee2012-submission-220.pdf.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, 18(1), 32-42.

Bruce, C. (1997). *The Seven Faces of Information Literacy*. Adelaid Auslib Press.

Bruce, C. (1998). The Phenomenon of Information Literacy. *Higher Education Research & Development*, 17(1), 25-43.

Bruce, C., Edwards, S., & Lupton, M. (2006). *Six Frames for Information Literacy Education: A Conceptual Framework for interpreting the Relationships between Theory and Practice*. 5(1) Retrieved from http://www.ics.heacademy.ac.uk/italics/vol5-1/pdf/sixframes_final%20_1_.pdf

Bullard, L & Eskridge, H N. (2011). The Literate Engineer: Infusing Information Literacy throughout an Engineering Curriculum. Paper presented at the *ASEE/ALD Annual Conference*, Chicago, March 11.

Canadian Engineering Accreditation Board Accreditation Criteria and Procedures. (2011). *Engineers Canada*.

Carroll, J. M. (1998). *Minimalism beyond the Nuremberg funnel*. MIT Press.

Case, J M & Light, G. (2103). Emerging Research Methodologies in Engineering Education Research. *Journal of Engineering Education Research*, vol 100, no 1, 186-210

Cox, C., & Lindsay, E. B. (Eds.). (2008). *Information Literacy Instruction Handbook*. USA: The American Library Association.

Coyne, M. & Saleh, N. Information Literacy in Undergraduate Engineering and Science Courses. Retrieved at http://library.queensu.ca/webeng/ppt/InformationLiteracy2009.ppt.

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing among Five Traditions (2nd Ed)*. Thousand Oaks, CA: Sage.

Creswell, J. W. (2008). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (3rd ed.). Upper Saddle River: Pearson.

Curzon, S. C., & Lampert, L. D. (Eds.). (2007). *Proven Strategies for Building an Information Literacy Program*. USA, New York: Neal-Schuman Publishers, Inc.

Denick, D., Bhatt, J., & Layton, B. E. (2010). Citation Analysis of Engineering Design Reports for Information Literacy Assessment. Retrieved at: http://idea.library.drexel.edu/handle/1860/3475

Doiulai, P. & Mandl, H. (1996). Computer And Information Literacy Skills For Professional Engineering Educators. , *Australasian Universities Power Engineering Conference (AUPEC'96)*, Melbourne, Australia, 2-4 October

Eisenberg, L., & Spitzer. (2004). *Information Literacy: Essential Skills For The Information Age* (2nd ed.). USA: Libraries Unlimited.

Feldman, L. & Feldman, J. (2000). Developing Information Literacy Skills In Freshman Engineering Technology Students. *30th ASEE/IEEE Frontiers in Education Conference*, Oct. 18-21, Kansas City, Mo.

Fitzwter, D., & Geesaman, J. (2003). Information Literacy Across The Curriculum Action Plan. Paper submitted by *The Information Literacy across the curriculum (ILAC) Continuous Improvement Team for College of DuPage, USA*.

Fjalbrant, N. & Levy, P.C. (1999). Information Literacy Courses In Engineering And Science – The Design And Implementation Of The DEDICATE Courses. *Proceedings of the IATUL Conferences*. Purdue University, Purdue e-Pubs.

Flyvbjerg, B. (2006). Five Misunderstandings About Case Study Research. *Qualitative Inquiry*, vol. 12, no. 2, April, pp. 219-245.

Flyvbjerg, B. (2011). *Case study*. N. K. Denzin; & Y. S. Lincoln, (Eds.), The Sage Handbook Of Qualitative Research, 4th Edition (Thousand Oaks, CA: Sage), pp. 301-316.

Fosmire, M. (2012). Information Literacy And Engineering Design: Developing An Integrated Conceptual Model. *IFLA journal*, 38(1), 47-52.

Gavin, C. (2008). *Teaching Information Literacy: A Conceptual Approach*. USA: Scarow Press, Inc.

Grassina, E. S. & Kaplowitz, J. R. (2001). *Information Literacy Instruction: Theory And Practice*. USA: Neal-Schuman Publishers, Inc.

Head, A. J., & Eisenberg, M. B. (2010). How Today's College Students Use Wikipedia For Course-Related Research. *First Monday*, 15(3), 1.

Johnson, W. G. (2008). The Application Of Learning Theories To Information Literacy. *College & Undergraduate Libraries*, 14(4), 103-120.

Johnston, B., & Webber, S. (2003). Information Literacy In Higher Education: A Review And Case Study. *Studies in Higher Education*, 28(3), 335-352.

Kreber, C. (2010). Academics' Teacher Identities, Authenticity, And Pedagogy. *Studies in Higher Education*, 35(2), 171-194.

Kirschner, P A, Sweller, J & Clark, R E. (2004). Why Minimal Guidance During Instruction Does Not Work: An Analysis Of The Failure Of Constructivist, Discovery, Problem-Based, Experiential And Inquiry-Based Teaching. *Educational Psychologist*, 41(2), 75-86.

Kuhlthau, C., Heinstrom, J., & Todd, R. J. (2008). The 'Information Search Process' Revisited: Is The Model Still Useful? *Information Research*, 13(4)

Leckie, G., & Fullerton, A. (1999). Information Literacy In Science And Engineering Undergraduate Education: Faculty Attitudes And Pedagogical Practice. *College and Research Libraries*, 60(1), 9-29.

Li, P. (2011). Science Information Literacy Tutorials And Pedagogy. *Evidence Based Library and Information Practice*, 2011, 6.2.. Retrieved at http://ejournals.library.ualberta.ca/index.php/EBLIP/article/view/9480

Liu, T. and Sun, H. (2011). Analysis Of Information Literacy Education Strategies For College Students Majoring In Science And Engineering. *Modern Applied Science*, vol 5, no5, 227-231. Retrieved at http://ccsenet.org/journal/index.php/mas/article/view/12498

Liu, T. and Sun, H. (2012). Gender Differences On Information Literacy Of Science And Engineering Undergraduates. I.J. Modern Education and Computer Science, 2, 22-10. Published Online March 2012 in MECS (http://www.mecs-press.org/).

Lynch, C. (1998). Information Literacy And Information Technology Literacy: New Components In The Curriculum For A Digital Culture. *Committee on Information Technology Literacy.* Retrieved October 2008.

Marra, R M, Palmer, B & Litzinger, T A. (2000). The Effects Of A First-Year Engineering Design Course On Student Intellectual Development As Measured By The Perry Scheme. *Journal of Engineering Education*, vol 89, no 1, 39-45.

Markless, S. & Streatfield, D. Three Decades Of Information Literacy: Redefining The Parameters. Retrieved at: http://www.informat.org/pdfs/Streatfield-Markless.pdf

McCullough, C. (2006). Information Literacy: A Critical Component In Engineering Practice In The Twenty-First Century. *ASEE Southeast Section Conference*,

McGuinness, C. (2006). What Faculty Think-Exploring The Barriers To Information Literacy Development In Undergraduate Education. *The Journal of Academic Librarianship*, 32(6), 573-582.

Messer, Deborah and Kelly, Patricia and Poirier, Jocelyne. (2005). Engineering Information Literacy And Communication. *In Proceedings of the Twelfth International Conference on Learning*, Granada , Spain. Retrieved at eprints.qut.edu.au/1606/01/1606.pdf

Molnar, L., & Ondrisov, M. (2010). What Engineering Education Needs More: Computer Or Information Literacy? *Joint International IGIP-SEFI*, 19(22)

Mils, J E & Treagust (2003) Engineering education – is problem-based or project-based learning the answer? Australasian Journal of Engineering Education. Retrieved at www.aaee.com.au/journal/2003.mills_treagust03.pdf

Pavelish, M J. & Moore, W S. (1996). Measuring The Effect Of Experiential Education Using The Perry Model. *Journal of Engineering Education*, vol 85, no 4, 287-292.

Piaz, J.M.; Angeli, E.; Wagner, J.; Lawrick, E.; Moore, K.; Anderson, M.; Soderlund, L.; Brizee, A.; & Keck, R. (2013). *General Format*. Retrieved at: http://owl.english.purdue.edu/owl/resource/560/01/

Poirier, J. M. (2005). Connecting To Great Minds: An Information Literacy Framework For Final Year Students. *Proceedings of the 2005 ASEE/AaeE 4th Global Colloquium on Engineering Education*. Copyright © 2005, Australasian Association for Engineering Education" . Available at: http://eprints.qut.edu.au/1608/1/1608.pdf

Repanovici, A., Barbu, I. & Cristea, L. (2008). Information Literacy Learning Model For Engineering Students. *5th WSEAS/IASME International conference in ENGINEERING EDUCATION (EE08),* Heraklion, Greence, July 22-24, 2008. Retrieved at http://www.wseas.us/e-library/conferences/2008/crete/education/education08.pdf

Riedling, A. M. (2006). *Learning To Learn: A Guide To Becoming Information Literate In The 21 St Century* (2nd ed.). New York: Neal-Schuman Publishers, Inc.

Roberts, J.C. & Bhatt, J. I(2007). Innovative Approaches To Information Literacy Instruction For Engineering Undergraduate At Drexel University. *European Journal of Engineering Education*, col 42, issue 3, 243-251. Retrieved at: http://idea.library.drexel.edu/bitstream/1860/1566/1/Innovative_Approaches_to_Information_Literacy_Instruction_preprint.pdf

Rockman, I. F., & Breivik, P. S. (2004). *Integrating Information Literacy Into The Higher Education Curriculum: Practical Models For Transformation*. San Francisco: Jossey-Bass.

Ross, M C, Fosmire, M., Wertz, R E H., Cardella, M E. & Purzer, S. (2011). Lifelong Learning And Information Literacy Skills And The First Year Engineering Undergraduate: Report

Of A Self-Assessment. *ASEE*, 2011. Retrieved at:
http://library.queensu.ca/webeng/ppt/InformationLiteracy2009.ppt

Rugarcia, A, Felder, R M, Woods, D R & Stice, J E. (2000)/ The Future Of Engineering Education. I. A Vision For A New Century. *Chemical Engineering Education*, vol 34, no1, 16-25.

Schmidt, W. (1997). World-Wide Web Survey Research: Benefits, Potential Problems, And Solutions. *Behavior Research Methods*, 29 (2), 274-279.

Shepard, J. & Greene, R.W. (2003). *Sociology and You*. Ohio: Glencoe McGraw-Hill. pp. A–22. ISBN 0-07-828576-3.

Sirkin, R.M. (2006). *Statistics for the Social Science* (3rd ed.). Sage Publications.

Spink, A., & Cole, C. (Eds.). (2005). *New Directions In Cognitive Information Retrieval*. Springer.

Strife, M., Hensel, R., Armour-Gemmen, M. & Statler, B.M. (2012). Engineering A Bridge To Information Literacy. *ASEE 2012 Annual Meeting*, June 10-13, 2012.

Tensen, B., L. (2004). *Research Strategies For A Digital Age*. Canada: Thomson, Wadsworth.

Thomas, G. (2011). A Typology For The Case Study In Social Science Following A Review Of Definition, Discourse, And Structure. *Qualitative Inquiry*, 17, 6, 511-521

Warlick, D. (2009). *Redefining literacy 2.0* (2nd ed.) Linworth Publishing, Inc.

Warner, D. A. (2008). *A Disciplinary Blueprint For The Assessment Of Information Literacy*. Libraries Unlimited.

Woods, D R, Hymak, A N, Marshall, R R, Wood, P E, Hoffman, T W, Wright, J D, Taylor, P A, Woodhouse, K A & Bouchard, C G. (2013) Developing Problem-Solving Skills: The

Mcmaster Problem Solving Program. *Journal of Engineering Education*, vol 86, no 2, 75-91.

Welker, A.I., Fry, A., McCarthy, L. & Komlos, J. An Integrated Approach To Information Literacy Instruction In Civil Engineering. *Fall 2010 Mid-Atlantic ASEE Conference*, October 15-16, 2010, Villanova University. Retrieved at: http://www.asee.org/documents/sections/middle-atlantic/fall-2010/01-An-Integrated-Approach-to-Information-Literacy-Instruction-i.pdf

White, M. V. (2003). Information Literacy Programs. *The Reference Librarian*, 38(79), 323-334.

Yin, Robert K. (2009). *Case Study Research: Design And Methods*. Fourth Edition. SAGE Publications. California, ISBN 978-1-4129-6099-1

Presentations

Bullard, L.G. & Eskridge, H.N. The Literate Engineer: Infusing Information Literacy Skills Throughout Engineering Curriculum. Retrieved at http://www.docstoc.com/docs/98426528/The-Literate-Engineer-Infusing-Information-Literacy-Skills-

Coyne, M. & Saleh, N. Information Literacy In Undergraduate Engineering And Science Courses. Retrieved at http://library.queensu.ca/webeng/ppt/InformationLiteracy2009.ppt

Ross, M C, Fosmire, M., Wertz, R E H., Cardella, M E. & Purzer, S. (2011). Lifelong Learning And Information Literacy Skills And The First Year Engineering Undergraduate: Report Of A Self-Assessment. *ASEE, 2011*. Retrieved at http://www.google.ae/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC4QFjAA&url=http%3A%2F%2Fdepts.washington.edu%2Fenglib%2Feld%2Fconf%2F2011%2FASEE2011_SelfAssessment_ross.pptx&ei=5dN0UZyeJ8f_rAfKooBQ&usg=AFQjCNGfogLe8y1U26B3m5WS21gf2bz8gA&bvm=bv.45512109,d.bmk

Strife, M., Hensel, R., Armour-Gemmen, M. & Statler, B.M. (2012). Engineering A Bridge To Information Literacy. *ASEE 2012 Annual Meeting*, June 10-13, 2012. http://www.google.ae/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&sqi=2&ved=0CCsQFjAA&url=http%3A%2F%2Fdepts.washington.edu%2Fenglib%2Feld%2Fconf%2F2012%2FEngineering%2520a%2520Bridge%2520to%2520Information%2520Literacy--Blue.pptx&ei=K-F0UYSdFsTqrAfU84HoBg&usg=AFQjCNHjgS3AR8-7VGzN1Jl8JlB1CYS2lQ&bvm=bv.45512109,d.bmk

APPENDICES

Appendix A: Questionnaires for professors

These questionnaires are part of the dissertation research project to earn a PhD degree in the educational technology from Concordia University.

The data that these questionnaires provide will be used to understand how professors understand the IL skills, what are the most important ILS that engineering students should have and how they acquire these IL skills.

Please note that these questionnaires will be treated as confidential and the information would be used only for research purposes. Results would be available upon request, or you can follow the research's update on the blog in the following address: information-issues.blogspot.com.

Before answering the survey questions you will asked to provide a five digit code comprising the first letter of your first name and the last four digits of your home, or primary, phone number. This code will be used to retrieve your form in the event you choose, at some point in time, to withdraw from the study.

Please write down your own unique number on the printed copy of the consent form that will be available on the survey page. This form will be retrieve only when a participant asks to withdraw from the survey.

1) Please circle the answer that describes you, or provide a response in the space provided::

    a. Which age group do you belong to:

        i. 30s

        ii. 40s

        iii. 50s

        iv. 60s +

    b. Your gender:

        i. Male

        ii. Female

    c. Your department or program (area of engineering socialization)? Please spicify…….

    d. Did you receive any of the following training before or during your teaching experience?

        i. Teaching skills yes no

        ii. Research skills yes no

        iii. Other (please specify) yes no

    e. Please rank the following skills in terms of their importance for your students' success, on a scale of 1-5, where 5 is "most important" and 1 is "least important":

        i. Ability to access information resources, store and use them.

        ii. Research skills

iii. Knowledge of computer technologies and tools for accessing, organizing, and processing knowledge.

iv. Writing skills

v. Library skills

vi. Visual skills and knowledge of applications for visualizing and interpreting information and data

vii. Communication skills

viii. Networking skills

ix. Problem solving skills

x. Critical thinking skills

xi. Decision making skills

xii. Professional standards

xiii. Ethics

xiv. Others

2) If you have a teaching problem or predicament, where do you go for assistance (indicate all relevant responses):

a. Educational department

b. Counseling department in the university

c. Certain services in the university (specify)

d. Ask a colleague

e. Consult the web

f. All the above

g. I know how to solve it without appealing to external assistance

h. Other (specify)

3) If you have a problem for embedding technology in teaching where do you go for assistance (indicate all relevant responses):

   a. Education department
   b. Certain services in the university (specify)
   c. Colleagues
   d. Web
   e. All the above
   f. I know how to solve it without appealing to external resources
   g. Others (specify)

4) If you have a problem with information usage where do you go for assistance (indicate all relevant responses):

   a. Education department
   b. Other services in the university (specify)
   c. Colleagues
   d. Web
   e. All the above
   f. I know how to solve it without appealing to external resources
   g. Others (specify)

5) If you assign a midterm paper, you would:

   a. Include guidelines and instructions about how to write a paper
   b. Assume the students know how to write such a paper

6) If students are not able to produce a course paper or assignment to the required standards, owing to their limited writing skills, your response is:
    a. Assign the appropriate low grade; my role on the goal of this class is not to teach writing styles.
    b. Direct students to seek help somewhere in the university (please specify)
    c. Provide additional feedback or support to the students yourself
7) Do you usually ask students to acquire different skills that you are not teaching" name or describe them.
8) What are the skills you assume that students should have when they walk into your class? Name them
9) Do you communicate the expectation that your students should have these skills to your classes? (yes/no) How do you accomplish this?
10) What are the key skills you expect that students should acquire after they finish your class?
11) Which skills should students acquire from their program by the time they graduate?
12) Would you invite a speaker to your class? (other than to address the topics of engineering)
    a. From outside the university
    b. From within the university
    c. What topic would you consider?

13) Have you been approached from different departments or services within the university to hold a workshop in your class or just to talk to the students? (yes/no) which ones and considering which topics?
14) In your opinion, what is the role of a librarian?
15) Do you think there is a role for librarians with respect to your classes? (yes/no) in what respect?
16) How do you define Information literacy (IL), and what are the skills, knowledge, or dispositions (attitudes) involved?
17) Have you read any sources on the subject of Information literacy skills (ILS)? (yes/no) which ones, if any and where did you access or acquire these sources? Did you access any sources you found helpful? Please comment
18) Are you aware of any position taken by profession accrediting body regarding the importance of ILS, or concerning objectives for engineering education programs that refer to ILS? (yes/no) if yes, can yes summarize this position, and do you agree or disagree
19) Where do students develop ILS? Please indicate the role of each option listed below on the scale of 1-5, where 1 means “not significant” and 5 means “most significant”?
    a. At home, or on their own time
    b. Through previous level of formal education
    c. Through activities in your engineering program
    d. Through activities in other formal university-level courses (e.g., elective course for your program)

e. Others (please specify)

20) What is your role in terms of developing and evaluating ILS? Please be specific or provide examples

21) Do you expect students to come to your classes with ILS already adequately developed? (yes/no). Any comments?

22) What do you think is the best way is to learn to develop ILS?

23) Are ILS generic? Or do they need to be understood within the context of the engineering field? (Generic/contextual)

24) What are the representative examples of how ILS are used in engineering?

25) How do students in your field general acquire these skills?

26) How did you, yourself, develop these skills?

27) How would you rate your own ILS?

   a. Very strong

   b. Strong

   c. Adequate

   d. In need of strengthening

28) Can ILS be measured or evaluated? (yes/no) if they are measurable please give examples of how you would measure or assess specific ILS within your classes

29) Do you incorporate any specific activities, strategies, or assignments to develop or test ILS in your own courses? (yes/no) please provide some examples, if you answered yes.

30) Do your students at different levels have sufficient ILS?

31) Do your students who graduate have a good enough ILS? (yes/no) if not, how critical is this issue? what is the impact on the profession and engineering firms? On engineering practice? On the individuals? How do you know if they do or do not have sufficient ILS?

32) How do ILS figure in the academic programs and courses in engineering? Please exlain how they appear in the criculim as objectives, topics, or activities or assignements?

33) How do ILS figure in the professional practice in the engineering work?

34) How critical are these skills in the profession and why? Can you give examples of how they used and where they are critical.

35) Has the information revoluation had a major impact on engineering as compared with other fields?

36) Do you rely of text books primarily for your classes? (yes / no) what other resources are involved?

37) Does independence on textbooks make it difficult to apply, develop or evaluate ILS? Please comment

38) What do you believe is the best solution to develop ILS in the context of engineering education? Are there any obstacles to ideal solution? What are the obstacles? Can they be overcome? If so, what is required, what changes are necessary? What is the best practical solution, given existing constrains.

39) Who do you believe should teach ILS in engineering:

   a. Engineering faculties

   b. Librarians

c. Educational technologists

d. Others

40) In your opinion, what is the best way to teach ILS in engineering:

a. Through a course for all university students

b. Through courses for engineering students

c. Through integrating ILS activities in the engineering topics

Appendix B: The focus group for engineering professors

The purpose of this round of these focus groups questions is to seek deeper understanding of some issues that are addressed in the survey, via a semi-structured approach with groups comprising 5-7 faculty members. I will attempt to include a mix of participants in terms of including different age, gender, and specializations. The questions fit in three categories:

1. ILS conceptualization:
   a. What are IL skills and what kind of IL skills do you acquire, and which IL skills do you need to acquire or update?
   b. How do you perceive the processes by which ILS skills are acquired and developed: How did you yourself acquire and hone these skills; what are optimal approaches/activities/strategies to acquiring these skills?
   c. Should ILS be defined in a general or generic way, or should we understand them specifically within the context of engineering or how they are employed within engineering?
2. ILS instruction:
   a. How are ILS addressed in your programs, if at all. Where and how do they figure in the curriculum; where and how should they figure; what are ideal approaches; what are the obstacles confronting optimal approaches; do you feel qualified to contribute to the development of ILS in your students and, if not, what additional training, resources or support would you require; are ILS (or some specific ILS) a responsibility of faculty and of

programs; is evaluation of competence with ILS a responsibility of faculty and programs?

3. Significance of ILS:

   a. Do students need specific ILS skills to succeed in their programs of study (and what are example that illustrate this requirement); does it differ depending on the level they have reached in the program; do professional bodies and employers emphasize the importance of these skills; how do we know these stakeholders regard the skills as critical?

Appendix C: Questionnaires for students:

Instructions are same as per faculty questionnaires. Please check the appropriate answer:

Demographic Info:

1. Age:
    a. 20
    b. 30
    c. 40+
2. Gender
    a. Male
    b. Female
3. What is your Department, program, specialization
4. What is your degree:
    a. Undergraduate
    b. Master
    c. PhD
5. Working experience in engineering? How many years? Role/job?
6. Information literacy skills:
    a. What is meant by “information literacy skills”? Please provide a brief definition.
    b. Have you heard the term used before in the context of your courses, program or assignments? If so, where?
    c. Using a scale of from 1-5, with 5 as “most important”, please indicate how important are the following skills and knowledge in the context of your engineering education:

i. Access, store and use information resources
ii. Research skills
iii. Knowledge of how to use applications for accessing, storing and using information sources (e.g., online library resources, google, flickr, social media…)
iv. Writing skills
v. Library skills
vi. Visual skills and knowledge of applications for visualizing and interpreting information and data
vii. Communication skills (e.g., presentation skills)
viii. Social networking skills
ix. Problem-solving skills
x. Critical thinking skills
xi. Decision-making skills
xii. Knowledge of professional standards
xiii. Ethics
xiv. Others (specify)

d. Using a scale of from 1-5, with 5 as "most important", please indicate how important are the following skills in the context of your future professional employment?

i. Research skills
ii. Knowledge of applications for accessing, storing and using information sources (e.g., online library resources, google, flickr, social media…)
iii. Writing skills

iv. Library skills
v. Visual skills and knowledge of applications for visualizing and interpreting information and data
vi. Communication skills (e.g., presentation skills)
vii. Social networking skills
viii. Problem-solving skills
ix. Critical thinking skills
x. Decision-making skills
xi. Knowledge of professional standards
xii. Ethics

7. What do you believe are the most important skills you must possess when you start university?
8. With regard to the skills and knowledge that are important during your academic studies in engineering: Do these change from one year to the next? If so, what skills become important or more important as you progress?
9. What are the most important skills you should have when you graduate?
10. Are all the required or important skills you have identified above taught in your classes? Which ones are not taught?
11. For the skills identified above which are taught, how is this done?
12. What resources do you use in your courses, in your present year of studies:
    a. Textbook
    b. Journal articles
    c. Online resources (applications, whitepapers, professional publications, blogs,news feeds….)

   d. Other

13. On a scale of 1-5 (with 5 meaning "most important" how important are skills concerning the ability to find, evaluate, store and apply information sources in your field of engineering, in the context of the professional workplace?

Appendix D – Consent form for Focus Group

CONSENT TO PARTICIPATE

I understand that I have been asked to participate in a program of research being conducted by Roukana Sanjakdar of the Education Department of Concordia University (*contact info including phone and e-mail).*
The work will be supervised by Steven Shaw, Associate Professor, Department of Education (shaw@education.concrodia.ca, tel 514-848-2424 x 2044)

A. PURPOSE

I have been informed that the purpose of the research is to collect information concerning faculty conception and perceptions relating to the nature and development of information literacy skills(ILS) , and their importance in academic studies and professional practice in the field of engineering. Ultimately, the results of this study may influence how ILS are studied in the future (how much emphasis on their specific application in particular domains is required, for example). Hopefully, with a better understanding of the questions addressed in the study, we will provide a better foundation on which to design and develop strategies to improve these skills among engineering students, leading to better performance in academic programs and in the workplace, taking into account relevant constraints and challenges..

B. PROCEDURES

This exercise will involve 4-7 participants, all engineering faculty, who will participate in a discussion concerning the nature and importance of information literacy skills in engineering education and practice, the approaches to developing and evaluating these skills, the role of faculty in these activities, and the relevant challenges and constraints. The researcher will serve as moderator, posing questions for comment and discussion, and taking notes. If you agree, unanimously, the proceedings will also be audio-recorded to facilitate accurate recall and summarization. After the session, the researcher will prepare a summary of the discussion and provide this to each participant. You will have an opportunity to comment, providing any corrections or clarifications you think are appropriate, as well as any additional comments you may have on the topics, or the focus group exercise.

C. RISKS AND BENEFITS

Your responses are confidential. The data you provide may be used individually or in aggregate form, in publications, presentations and reports, and in the researcher's dissertation. If any response or comment is such that it might be used to identify you, then this element will be removed. There are thus no specific risks attached to participating in this study. As a benefit, you may contribute to the improvement of training and education for engineering students through the information you provide, and its subsequent analysis.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at anytime (please contact Roukana Sanjakdar: roukana@gmail.com) without negative consequences.

- I understand that my participation in this study is

  CONFIDENTIAL (i.e., the researcher will know, but will not disclose my identity)

- I understand that the data from this study may be published.

☐I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print) ____

SIGNATURE ____

❑I wish to receive a copy of the final research report for this study.

If at any time you have questions about the proposed research, please contact the study's Principal Investigator:

Steven Shaw

Department of Education

Concordia University

1455 de Maisonneuve Blvd W, Montreal, QC h3g 1m8

Tel : 514-848-2044 x 2044

Email : shaw@education.concordia.ca

Date :

Signature :

If at any time you have questions about your rights as a research participant, please contact the Research Ethics and Compliance Advisor, Concordia University, 514.848.2424 ex. 7481 ethics@alcor.concordia.ca

☐I agree that the proceedings of this focus group may be audio-recorded to ensure more accurate recollection by the researcher.

SIGNATURE

____

Date:

Appendix E – Consent form for Online Surveys of Faculty and Students

Please read this information concerning your consent to participate in the study, carefully. If you agree to participate, indicate this is so by checking the appropriate box at the end of this section. You will not be able to proceed to the items in the survey until you have checked the box indicating you have read and understood this section. Checking the box means that you agree to participate in the study, and that the data you provide may be used in the ways, and for the purposes, that have been described to you

CONSENT TO PARTICIPATE

I understand that I have been asked to participate in a program of research being conducted by Roukana Sanjakdar of the Education Department of Concordia University (*contact info including phone and e-mail).*

The work will be supervised by Steven Shaw, Associate Professor, Department of Education (shaw@education.concrodia.ca, tel 514-848-2424 x 2044)

A. PURPOSE

I have been informed that the purpose of the research is to collect information concerning faculty conception and perceptions relating to the nature and development of information literacy skills(ILS) , and their importance in academic studies and professional practice in the field of engineering. Ultimately, the results of this study may influence how ILS are studied in the future (how much emphasis on their specific application in particular domains is required, for example). Hopefully, with a better understanding of the questions addressed in the study, we will provide a better foundation on which to design and develop strategies to improve these skills among engineering students, leading to better performance in academic programs and in the workplace, taking into account relevant constraints and challenges..

B. PROCEDURES

This exercise will involve 200-250 participants of engineering faculty (males and females), and 200-250 of under graduate engineering students, who will participate in an on line questionnaires concerning the nature and importance of information literacy skills in engineering education and practice, the approaches to developing and evaluating these skills, the role of faculty in these activities, and the relevant challenges and constraints. The engineering faculty and undergraduate students in both universities will be invited by emails to participate in the questionnaires on line. A thank you letter will follow their participation.

C. RISKS AND BENEFITS

Your responses are anonymous. The data you provide may be used individually or in aggregate form, in publications, presentations and reports, and in the researcher's dissertation. If any response to an open-ended item (e.g.,"please explain" or "please comment") is such that it might be used to identify you, then this element will be removed. There are thus no specific risks attached to participating in this study. As a benefit, you may contribute to the improvement of training and education for engineering students through the information you provide, and its analysis.

It is good to mention that since employing the use of cloud storage (the Survey Monkey), it requires to highlight that the data will be stored on "*international servers and/or housed by U.S. service providers and confidentiality can only be assured up to the point where information is accessed/requested by authorities as per local law (ex. U.S. patriot Act).*"

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at anytime (Please contact Roukana Sanjakdar: roukana@gmail.com) without negative consequences.

- I understand that my participation in this study is

  Anonymous (i.e., the researcher will not know my identity)

- I understand that the data from this study may be published.

❑I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

Date:

Signature:

Your code*:

Note: If you wish to receive a copy of the final research report, contact researcher's info.

If at any time you have questions about the proposed research, please contact the study's Principal Investigator:

Steven Shaw

Department of Education

Concordia University

1455 de Maisonneuve Blvd W, Montreal, QC h3g 1m8

Tel : 514-848-2044 x 2044

Email : shaw@education.concordia.ca

Date:

signature:

If at any time you have questions about your rights as a research participant, please contact the Research Ethics and Compliance Advisor, Concordia University, 514.848.2424 ex. 7481 ethics@alcor.concordia.ca

*To be able to withdraw at any time from the survey, you email the co-investigator with your own unique code. This code that you form from your first letter of your first name and the last digit number of your home phone number, keeps you anonymous for researchers while analyzing the data

Appendix F – statistical analysis - Professors

Statistical analysis:

When asking the Professors how to evaluate the importance of skills to the students' success, basic statistical analysis run including a t test to clarify any difference between the two groups. The following table of 300 has the details:

				t-test	
Ability to access information resources, store and use them.	Mean	4.27	4.21	0.88	No significant difference between universities
	St. Deviation	1.10	0.80		
	Mode	5	5		
	Min	2	3		
	Max	5	5		
	No. of responses	15	14		
Research skills.	Mean	3.73	3.64	0.78	No significant difference between universities
	St. Deviation	1.03	0.63		
	Mode	4	4		
	Min	2	3		
	Max	5	5		
	No. of responses	15	14		
Knowledge of computer technologies and tools for accessing, organizing and processing knowledge.	Mean	4	4.07	0.85	No significant difference between universities
	St. Deviation	1.25	0.62		
	Mode	5	4		
	Min	1	3		
	Max	5	5		
	No. of responses	15	14		
Writing skills.	Mean	4	3.71	0.46	No significant difference between universities
	St. Deviation	1.07	0.99		
	Mode	5	4		
	Min	2	2		
	Max	5	5		

	No. of responses	15	14		
Library skills.	Mean	3.67	2.92	0.12	No significant difference between universities
	St. Deviation	1.18	1.26		
	Mode	4	4		
	Min	1	1		
	Max	5	5		
	No. of responses	15	13		
Visual skills and knowledge of applications for visualizing and interpreting information and data.	Mean	3.87	4.07	0.46	No significant difference between universities
	St. Deviation	0.64	0.83		
	Mode	4	4		
	Min	3	3		
	Max	5	5		
	No. of responses	15	14		
Communication skills.	Mean	4.40	3.79	0.1	No significant difference between universities
	St. Deviation	0.63	1.25		
	Mode	5	5		
	Min	3	1		
	Max	5	5		
	No. of responses	15	14		
Networking skills.	Mean	4.27	3.86	0.22	No significant difference between universities
	St. Deviation	0.88	0.86		
	Mode	5	4		
	Min	3	2		
	Max	5	5		
	No. of responses	15	14		
Problem-solving skills.	Mean	4.93	4.64	0.06	No significant difference between universities
	St. Deviation	0.26	0.50		
	Mode	5	5		
	Min	4	4		
	Max	5	5		
	No. of responses	15	14		

Critical thinking skills	Mean	4.80	4.64	0.36	No significant difference between universities
	St. Deviation	0.41	0.50		
	Mode	5	5		
	Min	4	4		
	Max	5	5		
	No. of responses	15	14		
Decision making skills.	Mean	4.47	4.36	0.73	No significant difference between universities
	St. Deviation	0.83	0.84		
	Mode	5	5		
	Min	3	2		
	Max	5	5		
	No. of responses	15	14		
Professional standards skills	Mean	4.86	4.29	0.03	Professors at Concordia University give more importance to professional standard skills thanprofessors at the University of Sharjah
	St. Deviation	0.53	0.73		
	Mode	5	5		
	Min	3	3		
	Max	5	5		
	No. of responses	14	14		
Ethics	Mean	4.93	4.64	0.06	No significant difference between universities
	St. Deviation	0.26	0.50		
	Mode	5	5		
	Min	4	4		
	Max	5	5		

Then when asking the Professors where do students develop ILS, the answers are in the following table:

		Con	UOS	t test	
At home or on their own time	Mean	2.85	2.55	0.57	No significant difference between universities
	St. Deviation	1.21	1.37		
	Mode	3	1		
	Min	1	1		
	Max	5	5		
	No. of responses	13	11		
Through previous levels of formal education	Mean	3.93	4	0.82	No significant difference between universities
	St. Deviation	0.73	0.91		
	Mode	4	4		
	Min	3	2		
	Max	5	5		
	No. of responses	14	13		
Through activities in your engineering program	Mean	4	4.23	0.31	No significant difference between universities
	St. Deviation	0.55	0.60		
	Mode	4	4		
	Min	3	3		
	Max	5	5		
	No. of responses	14	13		
Through activities in other formal university-level courses (e.g. elective courses)	Mean	3.85	3.42	0.13	No significant difference between universities
	St. Deviation	0.69	0.67		
	Mode	4	4		

	Min	3	2
	Max	5	4

Table 300

Professors' data

Appendix G: Students Survey

Distribution of respondents based on departments

Dept

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	94	71.2	88.7	88.7
	2	7	5.3	6.6	95.3
	3	2	1.5	1.9	97.2
	4	1	.8	.9	98.1
	5	1	.8	.9	99.1
	6	1	.8	.9	100.0
	Total	106	80.3	100.0	
Missing	System	26	19.7		
Total		132	100.0		

Where:

Civil Eng = 1

Software Engineering = 2

Computer science = 3

Mechanical Eng = 4

Industrial Eng = 5

Dept

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	94	71.2	88.7	88.7
	2	7	5.3	6.6	95.3
	3	2	1.5	1.9	97.2
	4	1	.8	.9	98.1
	5	1	.8	.9	99.1
	6	1	.8	.9	100.0
	Total	106	80.3	100.0	
Missing	System	26	19.7		

Architectural Eng = 6

Important note: No statistically significant differences could be found due to the effects of programs on dependent variables because:

1. there is a big difference in sample size drawn from the different programs
2. sample size drawn from programs 2-6 is very small
3. there are too many missing points (26 in total)

Distribution based on gender

Gender:1=m;2=f

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	90	68.2	75.6	75.6
	2	29	22.0	24.4	100.0
	Total	119	90.2	100.0	
Missing	System	13	9.8		
Total		132	100.0		

Important note: There is a big difference in sample size between male and female students. This weakened the statistical analysis.

Distribution based on age

Age: 1=20s; 2=30s; 3=40s

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	103	78.0	85.1	85.1
	2	17	12.9	14.0	99.2
	3	1	.8	.8	100.0

	Total	121	91.7	100.0	
Missing	System	11	8.3		
Total		132	100.0		

Important note: No statistically significant differences could be found due to the effects of age on dependent variables because:

1. there is a big difference in sample size drawn from the different age groups
2. sample size drawn from age groups 2 and 3 is very small
3. there are too many missing points (11 in total)
4. grouping age of respondents in clusters of 10 years which made the analysis less sensitive to the age factor.

Distribution based on work experience

Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	8.3	25.0	25.0
	0.18	1	.8	2.3	27.3
	0.25	1	.8	2.3	29.5
	0.33	1	.8	2.3	31.8
	1	6	4.5	13.6	45.5
	1.5	2	1.5	4.5	50.0
	2	5	3.8	11.4	61.4
	2.5	1	.8	2.3	63.6
	3	1	.8	2.3	65.9
	4	1	.8	2.3	68.2
	5	5	3.8	11.4	79.5
	6	1	.8	2.3	81.8
	8	3	2.3	6.8	88.6
	10	2	1.5	4.5	93.2
	12	2	1.5	4.5	97.7

	25	1	.8	2.3	100.0
	Total	44	33.3	100.0	
Missing	System	88	66.7		
Total		132	100.0		

Important note: No statistically significant differences could be found due to the effects of experience on dependent variables because:

1. sample size drawn from almost all experience groups is very small
2. there are too many missing points (88 in total).

R Square Values and Regression Analysis Results for All Dependent Variables

Current Studies

Dependent Variable: CSInfoAccessSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.369[a]	.136	-.014	1.328

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.591	1.253		2.067	.050
	Age:1=20s;3=40s	.589	.803	.222	.733	.471
	Gender:1=m;2=f	.525	.568	.189	.925	.365
	Dept	-.230	.419	-.106	-.548	.589
	Experience	.042	.109	.121	.386	.703

a. Dependent Variable: CSInfoAccessSkls

Dependent Variable: CSResearchSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.373[a]	.139	-.010	1.172

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.601	1.105		2.353	.028
	Age:1=20s;3=40s	.385	.708	.164	.544	.592
	Gender:1=m;2=f	.506	.501	.207	1.011	.323
	Dept	.034	.369	.018	.092	.928
	Experience	.066	.096	.214	.686	.500

a. Dependent Variable: CSResearchSkls

Dependent Variable: CSApplicKnlge **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.227[a]	.052	-.121	1.137

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.619	1.079		3.355	.003
	Age:1=20s;3=40s	.500	.688	.233	.728	.474
	Gender:1=m;2=f	-.129	.494	-.058	-.262	.796
	Dept	-.086	.367	-.049	-.235	.817
	Experience	-.010	.094	-.035	-.106	.917

a. Dependent Variable: CSApplicKnlge

Dependent Variable: CSWritingSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.328[a]	.108	-.048	1.079

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.672	1.018		3.608	.001
	Age:1=20s;3=40s	.256	.652	.121	.393	.698
	Gender:1=m;2=f	-.018	.461	-.008	-.038	.970
	Dept	-.171	.340	-.099	-.502	.620
	Experience	.057	.089	.204	.642	.527

a. Dependent Variable: CSWritingSkls

Dependent Variable: CSLibrarySkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.102[a]	.010	-.169	1.214

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.232	1.145		2.822	.010
	Age:1=20s;3=40s	-.152	.740	-.068	-.205	.839
	Gender:1=m;2=f	.235	.539	.097	.435	.668
	Dept	.056	.386	.031	.145	.886
	Experience	.021	.100	.072	.213	.834

a. Dependent Variable: CSLibrarySkls

Dependent Variable: CSVisualSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.220[a]	.049	-.124	1.140

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.161	1.141		3.648	.001
	Age:1=20s;3=40s	-.197	.774	-.090	-.255	.801
	Gender:1=m;2=f	-.326	.498	-.141	-.655	.519
	Dept	.270	.361	.156	.747	.463
	Experience	-.003	.101	-.012	-.033	.974

a. Dependent Variable: CSVisualSkls

CSCommunicSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.201[a]	.041	-.134	1.315

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.080	1.247		2.470	.022
	Age:1=20s;3=40s	.035	.795	.014	.044	.965
	Gender:1=m;2=f	-.001	.571	.000	-.003	.998
	Dept	.352	.425	.174	.829	.416
	Experience	.030	.109	.093	.277	.784

a. Dependent Variable: CSCommunicSkls

CSSocialNtwSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.281[a]	.079	-.089	1.302

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.937	1.267		2.319	.030
	Age:1=20s;3=40s	.948	.788	.380	1.203	.242
	Gender:1=m;2=f	-.089	.568	-.034	-.156	.877
	Dept	-.242	.413	-.120	-.585	.564
	Experience	-.105	.109	-.318	-.967	.344

a. Dependent Variable: CSSocialNtwSkls

Dependent Variable: CSProbSolvSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.340[a]	.115	-.039	.934

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.322	.881		4.906	.000
	Age:1=20s;3=40s	.342	.565	.186	.606	.550
	Gender:1=m;2=f	-.435	.399	-.226	-1.090	.287
	Dept	.367	.294	.245	1.245	.226
	Experience	-.026	.077	-.107	-.339	.738

a. Dependent Variable: CSProbSolvSkls

CSCriticThnkSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.457[a]	.209	.065	.977

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.641	.922		3.947	.001
	Age:1=20s;3=40s	.322	.591	.157	.545	.591
	Gender:1=m;2=f	-.376	.418	-.179	-.900	.378
	Dept	.545	.309	.335	1.761	.092
	Experience	.028	.082	.100	.338	.739

a. Dependent Variable: CSCriticThnkSkls

CSCriticThnkSkls * Dept Crosstabulation

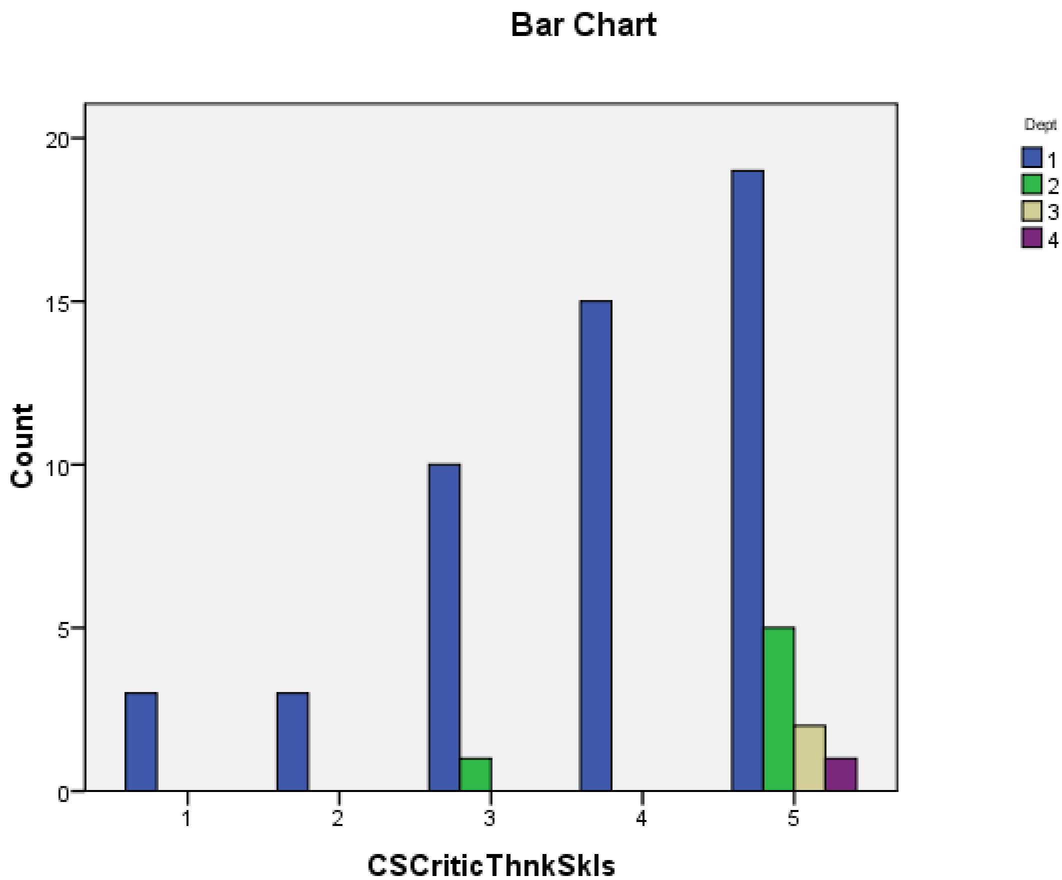
Count

		Dept				Total
		1	2	3	4	
CSCriticThnkSkls	1	3	0	0	0	3
	2	3	0	0	0	3
	3	10	1	0	0	11
	4	15	0	0	0	15
	5	19	5	2	1	27

CSCriticThnkSkls * Dept Crosstabulation

Count

		Dept				Total
		1	2	3	4	
CSCriticThnkSkls	1	3	0	0	0	3
	2	3	0	0	0	3
	3	10	1	0	0	11
	4	15	0	0	0	15
	5	19	5	2	1	27
Total		50	6	2	1	59



Dependent Variable: CSDecisMakSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.275[a]	.076	-.085	1.036

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.137	.977		4.233	.000
	Age:1=20s;3=40s	.053	.626	.027	.085	.933
	Gender:1=m;2=f	-.190	.443	-.091	-.430	.671
	Dept	.025	.327	.016	.077	.939
	Experience	.057	.085	.217	.672	.508

a. Dependent Variable: CSDecisMakSkls

CSKnowlgProfStnds **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.305[a]	.093	-.065	1.192

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.183	1.124		2.832	.009
	Age:1=20s;3=40s	-.177	.720	-.076	-.246	.808
	Gender:1=m;2=f	.114	.509	.047	.224	.825
	Dept	.499	.376	.265	1.329	.197
	Experience	.065	.098	.214	.667	.511

a. Dependent Variable: CSKnowlgProfStnds

Dependent Variable: CSEthics **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.324[a]	.105	-.058	1.259

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.731	1.225		2.230	.036
	Age:1=20s;3=40s	.329	.762	.134	.432	.670
	Gender:1=m;2=f	-.035	.549	-.014	-.064	.950
	Dept	.561	.400	.284	1.405	.174
	Experience	.017	.105	.051	.158	.876

a. Dependent Variable: CSEthics

Future Employment

Dependent Variable: FEResearchSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.415[a]	.172	.028	1.075

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.393	1.014		3.346	.003
	Age:1=20s;3=40s	-.419	.650	-.191	-.645	.525
	Gender:1=m;2=f	-.197	.460	-.086	-.428	.672
	Dept	.584	.339	.328	1.724	.098
	Experience	.092	.088	.319	1.044	.308

a. Dependent Variable: FEResearchSkls

Dependent Variable: FEApplicKnlge **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.426[a]	.181	.039	1.165

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.672	1.099		2.432	.023
	Age:1=20s;3=40s	.833	.704	.349	1.182	.249
	Gender:1=m;2=f	-.224	.498	-.090	-.451	.656
	Dept	.041	.367	.021	.112	.912
	Experience	.023	.096	.073	.238	.814

a. Dependent Variable: FEApplicKnlge

Dependent Variable: FEWritingSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.483[a]	.234	.100	1.168

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.428	1.102		3.110	.005
	Age:1=20s;3=40s	.692	.706	.279	.980	.337
	Gender:1=m;2=f	-.624	.499	-.241	-1.249	.224
	Dept	.183	.368	.091	.498	.623
	Experience	.040	.096	.122	.416	.681

a. Dependent Variable: FEWritingSkls

Dependent Variable: FELibrarySkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.258[a]	.066	-.096	1.225

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.896	1.155		3.372	.003
	Age:1=20s;3=40s	-.456	.741	-.194	-.616	.544
	Gender:1=m;2=f	-.300	.524	-.122	-.573	.572
	Dept	-.168	.386	-.088	-.434	.668
	Experience	.083	.101	.268	.824	.418

a. Dependent Variable: FELibrarySkls

Dependent Variable: FEVisualSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.306[a]	.093	-.064	1.140

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.588	1.075		2.407	.025
	Age:1=20s;3=40s	.611	.689	.275	.887	.384
	Gender:1=m;2=f	.075	.487	.032	.153	.879
	Dept	.357	.359	.198	.995	.330
	Experience	-.012	.094	-.041	-.127	.900

a. Dependent Variable: FEVisualSkls

Dependent Variable: FECommunicSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.318[a]	.101	-.055	1.120

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.580	1.057		3.389	.003
	Age:1=20s;3=40s	.435	.677	.198	.642	.527
	Gender:1=m;2=f	-.300	.479	-.131	-.626	.538
	Dept	.430	.353	.241	1.219	.235
	Experience	-.010	.092	-.033	-.104	.918

a. Dependent Variable: FECommunicSkls

Dependent Variable: FESocialNtwSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.319[a]	.102	-.054	1.399

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.704	1.319		2.807	.010
	Age:1=20s;3=40s	1.086	.846	.396	1.284	.212
	Gender:1=m;2=f	-.417	.598	-.145	-.697	.493
	Dept	-.282	.441	-.127	-.640	.528
	Experience	-.159	.115	-.439	-1.378	.181

a. Dependent Variable: FESocialNtwSkls

Dependent Variable: FEProbSolvSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.304[a]	.092	-.066	.910

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.319	.858		5.033	.000
	Age:1=20s;3=40s	-.028	.550	-.016	-.051	.960
	Gender:1=m;2=f	-.232	.389	-.125	-.598	.556
	Dept	.324	.287	.225	1.128	.271
	Experience	.035	.075	.150	.468	.644

a. Dependent Variable: FEProbSolvSkls

Dependent Variable: FECriticThnkSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.358[a]	.128	-.024	.931

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.592	.878		5.230	.000
	Age:1=20s;3=40s	-.305	.563	-.165	-.541	.593
	Gender:1=m;2=f	-.174	.398	-.090	-.437	.666
	Dept	.192	.294	.128	.655	.519
	Experience	.098	.077	.402	1.278	.214

a. Dependent Variable: FECriticThnkSkls

Dependent Variable: FEDecisMakSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.413[a]	.171	.027	.949

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.249	.895		4.748	.000
	Age:1=20s;3=40s	.049	.574	.026	.086	.932
	Gender:1=m;2=f	-.383	.406	-.189	-.944	.355
	Dept	.301	.299	.192	1.007	.325
	Experience	.066	.078	.257	.841	.409

a. Dependent Variable: FEDecisMakSkls

Dependent Variable: FEKnowlgProfSkls **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.342[a]	.117	-.036	1.068

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.434	1.007		4.402	.000
	Age:1=20s;3=40s	-.024	.646	-.011	-.037	.971
	Gender:1=m;2=f	-.487	.457	-.221	-1.067	.297
	Dept	.256	.337	.149	.759	.455
	Experience	.049	.088	.177	.561	.580

a. Dependent Variable: FEKnowlgProfSkls

Dependent Variable: FEEthics **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.267[a]	.071	-.106	1.079

a. Predictors: (Constant), Experience, Dept, Gender:1=m;2=f, Age:1=20s;3=40s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.000	1.050		3.809	.001
	Age:1=20s;3=40s	.404	.659	.195	.613	.546
	Gender:1=m;2=f	-.258	.474	-.122	-.546	.591
	Dept	.138	.344	.085	.401	.692
	Experience	.007	.090	.024	.073	.943

a. Dependent Variable: FEEthics

Appendix – G - Results of Professors Survey

No statistically analysis could be done on the effects of department and gender age due to the high number of missing data points as well as due to the small sample size of all departments except civil engineering and of female respondents.

Results of regression analysis of age of respondents did not yield any statistically significant results. The only one that approached statistical significance (at $\alpha = 0.05$) was the decision making factor with p-value = 0.06. Below you can find a crosstabulation and a bar chart for this variable. A small sample size of age groups 30s and 60s, high number of missing data points and clustering the age of respondents into groups of 10 years made the analysis weaker.

It is anticipated that more balanced age, gender and age groups were going to produce more statistically significant results.

Here are regression analysis results of the age factor over rated variables in the survey.

Results of regression analysis of professors' age

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

1	.167[a]	.028	-.008	.955

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.694	.648		5.702	.000
	Age:1=30s;4=60s	.206	.235	.167	.879	.387

a. Dependent Variable: InfoAcccess

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.049[a]	.002	-.035	.864

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.

		B	Std. Error	Beta		
1	(Constant)	3.546	.586		6.048	.000
	Age:1=30s;4=60s	.054	.212	.049	.255	.801

a. Dependent Variable: ResearchSkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.206[a]	.042	.007	.978

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.338	.664		5.029	.000
	Age:1=30s;4=60s	.262	.240	.206	1.092	.284

a. Dependent Variable: CompKnowledge

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.017[a]	.000	-.037	1.044

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.923	.709		5.537	.000
	Age:1=30s;4=60s	-.023	.257	-.017	-.089	.930

a. Dependent Variable: WritingSkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.107[a]	.011	-.027	1.265

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.812	.958		2.937	.007
	Age:1=30s;4=60s	.188	.342	.107	.549	.588

a. Dependent Variable: LibrarySkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.149[a]	.022	-.014	.736

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	4.342	.500		8.691	.000
	Age:1=30s;4=60s	-.142	.181	-.149	-.783	.441

a. Dependent Variable: Visual Skills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.090[a]	.008	-.029	1.027

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.419	.697		6.343	.000
	Age:1=30s;4=60s	-.119	.252	-.090	-.471	.642

a. Dependent Variable: Communication Skills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.036[a]	.001	-.036	.899

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.958	.610		6.487	.000

	Age:1=30s;4=60s	.042	.221	.036	.189	.852

a. Dependent Variable: Networking Skills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.008[a]	.000	-.037	.420

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.804	.285		16.865	.000
	Age:1=30s;4=60s	-.004	.103	-.008	-.040	.968

a. Dependent Variable: ProbSolvSkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.025[a]	.001	-.036	.463

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.685	.314		14.912	.000
	Age:1=30s;4=60s	.015	.114	.025	.128	.899

a. Dependent Variable: CritThinkSkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.346[a]	.120	.087	.788

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.346[a]	.120	.087	.788

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.429	.535		6.415	.000
	Age:1=30s;4=60s	.371	.194	.346	1.915	.066

a. Dependent Variable: DecisMakSkills

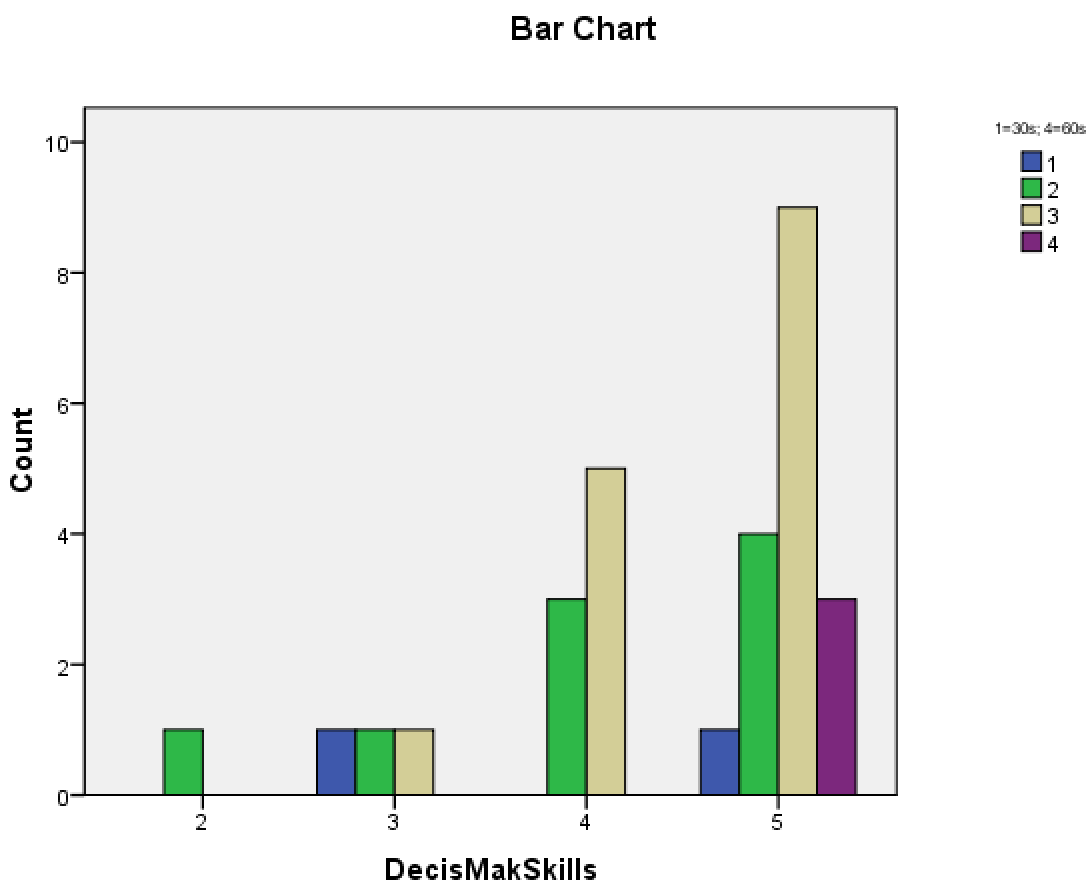
Crosstabs

DecisMakSkills * 1=30s; 4=60s Crosstabulation

Count

		1=30s; 4=60s				Total
		1	2	3	4	
DecisMakSkill	2	0	1	0	0	1

s	3	1	1	1	0	3
	4	0	3	5	0	8
	5	1	4	9	3	17
Total		2	9	15	3	29



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.118[a]	.014	-.024	.698

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.296	.474		9.061	.000
	Age:1=30s;4=60s	.104	.172	.118	.606	.550

a. Dependent Variable: ProfStndrdSkills

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.120[a]	.015	-.022	.417

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.965	.283		17.556	.000
	Age:1=30s;4=60s	-.065	.102	-.120	-.630	.534

a. Dependent Variable: Ethics

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.195[a]	.038	-.006	1.271

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.575	.964		3.709	.001

	Age:1=30s;4=60s	-.325	.348	-.195	-.934	.361

a. Dependent Variable: OwnTime

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.085[a]	.007	-.032	.821

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.220	.621		6.791	.000
	Age:1=30s;4=60s	-.095	.222	-.085	-.428	.672

a. Dependent Variable: PrevEduc

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.286[a]	.082	.045	.564

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.728	.427		11.069	.000
	Age:1=30s;4=60s	-.228	.153	-.286	-1.494	.148

a. Dependent Variable: EngProgActivities

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.089[a]	.008	-.035	.712

a. Predictors: (Constant), Age:1=30s;4=60s

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.417	.540		6.330	.000
	Age:1=30s;4=60s	.083	.194	.089	.429	.672

a. Dependent Variable: OtherCourses

Appendix – H – invitation letters

My name is Roukana Sanjakdar and I am a PhD candidate in educational technology at Concordia University, Montreal, Canada.

I am conducting a research project for my dissertation and I need your assistance. I would very much appreciate if you can spare me 30-45 minutes of your time to complete a survey online. The survey addresses the nature, role and significance of information literacy skills in engineering, both in academic contexts and in the profession. Clarification of these issues will allow us to inform policy and design better strategies and approaches to raise the level of these skills in engineering students – leading to better academic outcomes and performance in the context of professional work.

Your data will be treated as anonymous and only your answers will be used for the research purposes. Your name will not be required and so will not be included in any presentations or reports of the research.

The results of this research will be presented in a dissertation that is entitled: *Information Literacy skills (ILS) in Higher Education: Investigating ILs in Engineering from the professors' and students' perspectives.* This will be published as a PhD dissertation and be available in Concordia University's library. You can also get general updates on the project by visiting my blog : http://www.information-issues.blogspot.com.

It is possible that selected aspects of the research results will be published in educational journals or proceedings of conferences.

The research ultimately concerns an issue you may find of interest or significance, namely, the finding that faculty, at least, perceive students' ILS skills in Engineering as inadequate. Results of surveys of faculty across fields suggest this perception is stronger in engineering than in any other field, despite the growing importance of ILS in the perception of professional bodies and employers in the sphere of engineering. Better understanding of faculty and student conceptions of ILS, how they are developed and the role they play in education and professional practice will provide a basis for developing better solutions to this issue.

To participate in the survey, access the following url:

https://www.surveymonkey.com/s/XL3JFCV

and follow the instructions…..

Accessing and responding to the survey indicates your agreement to participate in this project. You are free to discontinue your participation at any time, without any negative consequences, by contacting me at the email address provided and providing your survey identification code. At the conclusion of the study, you will be able to access a concise summary of the findings by visiting my blog.

The survey will take (20-30 minutes – student survey) to complete. You must complete the items in one session and in the order they are presented.

If you have nay question you an emial: roukana@gmail.com

Your help is highly appreciated

Thanks in advance and best regards