Connecting to Great Minds: an Information Literacy Framework For Final Year Students

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Abstract
At the Queensland University of Technology (QUT), to address the ongoing challenges the engineering profession faces, teaching engineering academics and teaching librarians collaborate to initiate and develop Information Literacy programs that change the way engineering students engage in their disciplines.
Significant milestones such as the 'Advanced Retrieval Skills' program, the 'Learning For Life Information Literacy Framework and Syllabus' and the 'Teaching Capabilities Framework' demonstrate the universities engagement in shaping engineering graduate capabilities.
In accordance with a recent faculty review, the Information Literacy programs for the civil engineering students in the School of Urban Development were further developed and provided opportunities for stronger cooperation between academics and librarians. The transformational framework, '*Connecting to Great Mind: an Information Literacy for Final Year Students*' is an attempt to move beyond the Information Literacy debate in order to integrate Information Literacy into the curriculum. It is through a fourth year unit, CEB411 Thesis A that Resource-Based and Deep Learning demonstrate the necessity for teaching academics and librarians to undergo transformational competencies in their professions.
Evaluation of learning outcomes suggests that there is a relationship between students with advanced information retrieval skills and their ability to engage in the literature review process. This successful teaching collaboration and learning outcomes are encouraging and must continue.
All Information Literacy activities must be embedded through the entire curriculum. Common learning and teaching training programs for staff must occur to facilitate the development of literacies specific to engineering students. As part of professional practice, in entering a knowledge economy in a sustainable world, staff teaching all types of literacies in engineering must collaborate to advance programs and research in curriculum design and engage in interdisciplinary teams at international level.

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Introduction

This paper highlights a pathway designed to facilitate the students' ability to think, articulate their thoughts and finally connect to the great minds they meet while learning how to seek effectively and critically analyse a body of knowledge.
At the crossroads of transformational teaching and learning, in a worldwide environment, all stakeholders including universities, industries, professional associations as well as individuals are all looking for common understanding, knowledge and support. At QUT, the Faculty of Built Environment and Engineering (FBEE) provides Information Literacy (IL) frameworks that enable these processes. It is through programs like CEB411 Thesis A that final year students can go deeper into their learning, and that teaching academics can help in this exploration for these minds are ready to look for deeper meaning, purpose and understanding.

Background

Several factors contributed in harnessing transformational learning in the engineering curricula. The last decade of the 20th Century saw the birth of the "Information Age" and the emergence of "Knowledge Economy", a new economic model where information is seen as a 'building brick' and innovation based on learning [1]. The Internet undeniably revolutionised the way the world communicates and delivers information. Australia, a vast and remote continent, unequivocally embraced this new medium. In addition, as part of the requirements of the 'Washington Accord', Engineers Australia [2] and ABET [3,4], the U.S.A. Accreditation Board for Engineering and Technology, gives substantial attention to lifelong learning competencies. A supportive generic attributes based curricula is a driving force that works towards achieving sustainable development, reinforcing the idea that technological knowledge as important as it might be in solving difficult humanitarian issues is not an end in itself . After its 2004 Quinquennial Review, FBEE delivered its 'White Paper – The Founding Principles of the New Faculty'. It now sets the FBEE principles of future transformational change. It is in alignment with the QUT 'Blueprint 2004: Regenerate, Engage and Experiment'. At QUT, the delivery of programs integrating information retrieval skills was first introduced at postgraduate level. FBEE was instrumental and made the program IFN001, today still called AIRS (Advanced Information Retrieval Skills) compulsory. Never before, in terms of information seeking and access, had students and academics in engineering higher education been supported to reach that level of sophistication. The present QUT Information Literacy Framework that has been developed over the last decade now sits within the university teaching and learning portfolio. This development was enabled by the creation within the University Library of the Information Literacy Coordinator position and the Information Literacy Advisory Team (ILAT) who oversee the development of IL initiatives. IL initiatives and the integration of Information Literacy in all engineering professional studies are progressing. For the teaching academics and librarians who are collaboratively involved in designing these programs, teaching and learning common ground theories, practices and research

remain challenging but fruitful. Through the years, series of workshops have been gathering these practitioners and made the transformation possible.
FBEE professional studies are addressing the disparities in integrating lifelong learning programs. The first year professional studies BNB007 was created to set precedence in integrating core generic skills and modularising professional practice, communication, computing and graphics to encourage students to communicate research, organise, solve and present. The School of Civil Engineering (now part of the School of Urban Development) has developed over the years, professional studies at all year levels aiming to articulate the curriculum. CEB411 Thesis A is an extension of this curriculum development and brings a new dimension to final year Civil Engineering students' learning. CEB411 Thesis A students are introduced to how Research and Development is an important success factor in a competitive and global environment. Its aim is to further develop students' high level of graduate capabilities, civil engineering practices in a specific body of knowledge through literature investigation, analysis and critique; through experimentation, data collection and analysis; and through testing. Students are expected to demonstrate their ability to outline a program for future research, develop an understanding of sustainability, professional ethics and socially responsible engineering.

Beyond Definitions and Issues

For some time the debate around the definition of Information Literacy has hindered embedding it into the curriculum. In library literature, much debate surrounds the concept of Information Literacy and the attempts of integrating it into the curriculum. D'Angelo and Maid [5] described how a collaborative partnership between the library and a multimedia writing and technical communication course led to the revision of existing programs. Like many others, it was an attempt to move beyond the definitions and its integration in the curriculum. Worldwide, it is difficult for librarians to implement changes that would enable effective delivery of IL programs and extension of students' IL experiences. It is equally difficult for librarians to effectively communicate and work collaboratively with academics in delivering lifelong learning capabilities such as Information Literacy [6]. The idea that "techno-savvy [7] is equivalent to information literate" is a misconception that remains among students and academics. Also, timetables, roles and interpretations of stakeholders, relevancy of programs and teaching environments, all make it even more challenging. Developing a framework that combines all IL understandings is a difficult prospect [8]; instead there are many pathways that are being constructed around the world to integrate IL skills "seamlessly" into engineering curricula in order to achieve lifelong learning. Ultimately, at QUT, all faculty teaching members share the responsibility for IL programs with the teaching librarians. It is essential that a common understanding be adopted. Some programs in FBEE are designed to engage the students in critical and analytical thinking activities which allow the acquisition of lifelong learning skills; others encourage effective information seeking behaviours. Gradually, the abolishment of some mental barriers assists students with addressing the misconception that information technology skills and IL skills are interchangeable

rather than inter-dependable skills. Only, well thought-out curriculum approaches determine how lifelong learning programs can be successfully embedded.

Teaching and Learning Theories and Principles

The underpinning teaching and learning theories and principles that guided the development of '*Connecting to Great Mind: Information Literacy for Final Year Students*' are based on the author's own transformational learning and teaching journey. The following sections: Making Sense of the World, The Twelve Brain/Mind Learning Principles, The Literature Review Process and The Seven Faces of Information Literacy highlight these important encounters.

- Making Sense of the World

"The world in which we were raised or live significantly influences how we 'make sense' of our world and the need to work together as one large global community is becoming essential for continued existence" [9]. Making sense of the world is very much at the centre of FBEE Professional Studies units; in FBEE team projects encourage personal development in communication, as well as technological literacy through flexible platforms and cultural understandings. If teaching team work closely together, it is their positive and professional role modelling that most influence students' behaviours. In this, CEB411 Thesis A is no exception.

- The Twelve Brain/Mind Learning Principles

Understanding how students best learn is at the centre of teaching. Without paraphrasing too much, Caine et al [10] learning is a psycho physiological function and it is defined by twelve interconnected principles that educators must put into action to transform both learning and teaching. Three interactive elements emerge out of these twelve principles: "relaxed alertness", "orchestrated immersion in complex experience" and "active processing". While no one principle is more important than the other, the more principles and different aspects of these principles are introduced, the more students learning experiences will increase. To enrich students' learning environments, all of the following contribute to achieving the "ideal mental state for higher order functioning":

1. Engage the physiology in learning,
2. Engage social interactions,
3. Engage their innate search for meaning,
4. Engage their capacity to recognize and master essential patterns,
5. Engage emotional connections,
6. Engage their ability to perceive both details and the larger view,
7. Engage both their ability to focus attention and learn from the peripheral context,
8. Engage both conscious and unconscious processing,
9. Engage their capacity to learn from memorizing isolated facts <u>and</u> biographical events,
10. Acknowledge and engage developmental steps and shifts,
11. Reduce threat and enhance self-efficacy,
12. Engage their individual style and uniqueness.

Finally to transform learning and teaching approaches, educators must create optimum "emotional climate for learning", "opportunities for learning", "ways to consolidate learning". CEB411 Thesis A offers exceptional grounds to explore all of the above principles while engaging students in the Literature Review process.

- The Literature Review Process

Writing a dissertation literature review is problematic for students and they often require help with this process [11]. CEB411 Thesis A students have no previous experiences of what constitutes a Literature Review, they cannot envisage the complex conceptions of a Literature Review and they have no views on the scope of a Literature Review. Reflection is the approach adopted in CEB411 Thesis A and students are asked individually, in teams and then collectively, to define what a Literature Review is and its purpose. In general, students collectively address the majority of the conceptions. The Literature Review material in terms of presentations and handouts is made available to the students on their CEB411 Thesis A OLT (Online Learning and Teaching) Web Site. It is then for their supervisors to ensure that the process has a meaning, a purpose and is well understood. Teaching how to find and obtain the literature that pertains to their research topic is the teaching librarian's responsibility.

- The Seven Faces of Information Literacy

The students' "ability to locate, manage and use information effectively for a range of purposes", is one of the most accepted definitions of IL Studies that have contributed to further advance this concept, and another such as the "Seven Faces of Information Literacy" is further explored. Bruce [12], based on a phenomenological study, identified seven related phases ("Seven Faces") with interrelated elements and defined a relational model of Information Literacy. Catts [13], based on a statistical analysis study, confirmed the proposed relational model of information literacy. These research findings, based on qualitative and quantitative methodologies are encouraging. Information Literacy is a coherent concept. The relational model of information literacy can be used as a guide to understand and develop information literacy programs at QUT. The CEB411 Thesis A IL program is designed to take these findings into consideration and, during their studies, the students are taken through and reminded of the "Seven Faces of Information Literacy", namely:

1. *Information literacy is seen as using information technology for information retrieval and communication.*
2. *Information literacy is seen as finding information located in information sources.*
3. *Information literacy is seen as executing a process.*
4. *Information literacy is seen as controlling information.*
5. *Information literacy is seen as building up a personal knowledge base in a new area of interest.*
6. *Information literacy is seen as working with knowledge and personal perspectives adopted in such a way that novel insights are gained.*

7. *Information literacy is seen as using information wisely for the benefit of others.*

The Conceptual Framework

Over years students have been required to find information that substantiates their arguments, to research the literature that pertains to an area of interest or to engage in knowledge based activities in an analytical and critical way. Foci and assumptions on how to effectively retrieve information have overshadowed the mental process underlying the information seeking, selection and use processes. Mental leaps [14] of a higher degree had to be undertaken and missing links such as critical thinking, conceptualisation, cognitive [15], semantics and logic had to be introduced, tested, and evaluated in specific professional and research programs. Appropriate learning activities and assessments were designed and CEB411 Thesis A students respond well to this new IL framework.

Problem solving learning activities are well embedded in engineering curricula, while conceptualisation as an analytical, synthetically and holistic testing tool is overlooked [16], until in their fourth year engineering students are required to achieve a higher level of reasoning. Concept maps such as Knowledge Maps (KM) offer a way to include static and dynamic perspectives of the reasoning and the simplicity of its notation and its semantics makes it even more attractive. For students it re-enforces the need to learn how to draw concepts and inter-relate these concepts from the information they gather so they arrive at their own conclusions and according to the Cartesian method (1. Rule of evidence, 2. Rule of analysis, 3. Rule of synthesis and 4. Rule of proof). CEB411 Thesis A students select a research topic and with a supervisor come up with a problem relating to the topic. They define some attributes as a starting point to develop a visual diagram. It becomes apparent how their brain organise their ideas in the understanding process and it is a simple way for them to express and communicate to others complex ideas and undeniably, at such an early stage, a way to get started in the research process. In this process the students are required to describe what information is involved, where, when, why, what for and how. What is being tested here is the students' ability to verify and validate their reasoning against the concepts they drew from the information they gathered.
In CEB411 Thesis A concept mapping is used to assist the students with the thinking and conceptualisation process. It is easier to state facts than to articulate ideas and to furthermore translate these into concepts that are linked. Concept mapping is used to help the students to overcome this difficulty, to facilitate discovery learning, meaningful learning and reasoning since concepts are no longer seen as isolated entities but as existing in a network of relationships. The students design their concept map to demonstrate their ability to uncover associated and related concepts and supervisors are given the evidence that critical thinking skills are being developed and can be measured whilst complex concepts are being mastered. To further support the process, the students are advised to use simple downloadable and free software from the Internet. Some past students have preferred to use Microsoft Excel and an

example is provided on the CEB411 Thesis A Online Unit Web Site to encourage students to come up with their own initiatives. It is interesting to see how concept maps transform over a few weeks and how creative the students can be.

The opportunity to develop their ability in retrieving information effectively occurs in the information retrieval skills learning activities that take place in the IL workshops and tutorial sessions. Students searching information systems are confronted with an inability to use the terms that best describe the concepts they wish to explore. Information systems are structured in a way that requires the command of language and furthermore the knowledge of specific vocabulary referred to as the thesaurus (or: controlled vocabulary, index terms, descriptors, subject headings, to name only a few). Although each information system has its own architecture, common principles prevail. According to Fodor and Pylysshyn [15], "the ability to entertain a given thought implies the ability to entertain thoughts with semantically related contents". Information systems and therefore information seeking requires that not only do students need to master thoughts but a language of thoughts that is close enough to syntactic and semantic structures and a logic of thoughts to contribute to the successful retrieval of the literature they are seeking. The students formulate their information search strategies that demonstrate their ability to use appropriate terminology in their disciplines (e.g. use of controlled vocabulary) as well as their ability to demonstrate the logic of their thoughts (e.g. use of Boolean operators).

McKenzie [17] refers to the skills needed to achieve sustainable development as "critical literacy skills". As future builders of local and global sustainable communities, it is a transformational prospect for CEB411 Thesis A students [18]. CEB411 Thesis A students are provided with support and opportunity to better embrace some critical literacy skills. Methods of critical thinking and reading are presented to the students on their CEB411 Thesis A OLT (QUT online learning and teaching system) Unit Web Site. Additional support is usually required to assist some students, especially international students. This additional support is available through TALSS, the Teaching and Learning Support Services (Division of Technology, Information and Learning Services). LOLI, an interactive site houses relevant and useful learning support resources. It assists students with their academic skills development including time management, study management, group work, note taking, reading techniques, critical thinking, academic writing and planning for assignments and exams. During semesters, students may register to attend a series of activity-centred workshops that provide activities and strategies encouraging students to practise and refine their academics skills.

Program Delivery

CEB411 Thesis A IL program and learning activities include CEB411 Thesis A OLT Unit Web Site, I L workshops, IL tutorials, a citing and referencing session and consultations. All programs at QUT are allocated a space within OLT and it is possible for all students and staff to access and develop resources to enhance their learning and teaching. CEB411 Thesis A students and staff make use of this resource also as a one stop communication tool.

Two workshops are dedicated to the Literature Review process and IL skills. The first workshop introduces the students to what it is and what it is for a Literature Review. The second workshop is dedicated to how to get started. The construction of a concept map initiates the students' understanding and knowledge of their research topic while the formulation of information search strategies serves the purpose of better understanding and use of information systems.
A series of information retrieval skills tutorials are scheduled. Students nominate themselves to attend hands-on sessions. Sessions are designed to give some quality time and practical experience to students. No more than ten students are expected in these sessions. Therefore the number of sessions depends very much on the number of students enrolled in CEB411 Thesis A.
By their fourth year of their studies, Civil Engineering students are generally well rounded in citing and referencing the sources they use. When compiling their bibliography and their literature review report list of references the students are confronted with the amount and complexity of the sources encountered. An optional Endnote session is offered, whether they are creating a substantial Literature Review which includes a significant number of references or are just wishing to learn how to use this bibliographic software. In the session, the students are introduced to the basics that will enable them to record organise and make use of references retrieved while investigating the literature pertinent to their selected topic. They create their own library of references. Download references from library catalogues and remote information systems, link their references into their word processed literature review report and generate their bibliography as well as their list of references in the Harvard Style. Only a few students respond to this offer. Some students prefer to download the software and learn how to use it in their own time. Regardless the motivation, students find it very useful and are appreciative of the support given to them.
Consultations on a one to one basis are scheduled to ensure that all students are well on track. Students work in groups of two under the supervision of one academic staff. While they are expected to plan their own program, they are also expected to work on their thesis of an average one day a week, meet their supervisors at least every second week during semester, maintain a thesis diary to be discussed and signed off with the supervisor at each meeting, present a seminar. Each student in a group produces an individual thesis. Supervisors continue to monitor the entire process until the students present a satisfactory literature review report. If necessary, supervisors and the librarian discuss issues at the school institutionalised school weekly morning tea.

Assessment and Learning Outcomes

The IL component is assessed and weighted. It is an important factor as very often students comment on the time the process takes and on its usefulness. At the end of week 5, an assessment in three parts gives a snapshot of what the students have been able to achieve and gives an indication of where the problems may lie in relation to the difficulties of the chosen topic; the ability to conceptualise and find information. The supervisor and resource availability may be an obstacle to achieve the task in a

timely manner. The students present their information search strategies and include their information system selection and formatted bibliography. The information retrieval skills assessment represents a significant 15% of the total mark. At this stage both supervisors and the liaison librarian participate in the marking and feedback process. The sustainability and expertise of the marking and feedback process is under revision to ensure its management and quality. Over time, comparative analyses of the data reveal a relationship between information retrieval and learning outcomes. Students, who demonstrate their ability to conceptualise and make efficient use of relevant of information systems, find information that present similar and different perspectives and are able to form a viewpoint. Over time, a comparative data analysis indicates a relationship between students with advanced information retrieval skills and their ability to engage in the literature review process, unlike research findings such as Limberg's that rejects this type of relationship [19].

Conclusions

The transformational framework for students titled '*Connecting to Great Mind: an Information Literacy for Final Year Students*' gives evidence of an attempt to move beyond the information literacy debate in order to embed information literacy into the engineering curriculum. The fourth year unit, CEB411Thesis A, a Resource-Based Learning unit provides wonderful opportunities to explore Deep Learning at its highest. There is a need to further investigate the relationship that exists between the ability to better conceptualise, better formulise information search strategies when using relevant information systems and the ability to critically analyse the literature pertaining to a research topic. There is a need for forging stronger cooperation between academics and librarians and a need for academics and librarians to undergoing transformational competencies in their respective professions. Therefore, it is essential that collaborative approaches continue and improve the articulation, the planning, the content, the delivery and the evaluation of all information literacy programs through the entire engineering curriculum.
It is imperative that common learning and teaching training programs such as the generic Graduate Certificate in Higher Education be recommended to teaching staff and be developed to integrate 'literacies' specific to engineering students and it is vital that staff teaching all types of 'literacies' in engineering do work to advance programs and research in curriculum design at international level. Finally, as a role model, the entire engineering teaching community will have to demonstrate to its students how rewarding it is to engage in team work, interdisciplinary and international collaboration as part of professional practices.
This is a great move forward into a knowledge and sustainable world.

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