# Information, Competencies and Collaborative Teaching/Learning

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*Abstract* — *The purpose of this paper is to survey the literature about current trends on several issues concerning technical information education including: 1. Information needs, user behaviors, access and availability of engineering information resources. 2. Information competencies as perceived by librarians and teaching faculty. 3. Initiatives encouraging collaborative teaching or learning to enhance the information competency of engineering and technology students. The author examines activities in these three areas, the role of professional societies, and the effect of technology in the classroom. Based of the results of this survey, the author tries to identify the main components in a system of technical communication as it pertains to the education of engineering students. A better understanding of this system can help in developing programs to prepare students in better managing technical information.*

## INTRODUCTION

Engineering and technology students are confronted with an increasing number of technical information systems and resources. There is also an increased emphasis in educating and preparing students for a complex world where products and services are designed and developed in a business environment characterized by the inter-nationalization of information, resources, and markets. With this in mind, engineering faculty and librarians often interact to find significant ways to ensure that future engineers are going to be prepared to handle the number of information resources available to them.

In this article, I will try to identify factors affecting students and engineers as well as faculty members in the process of acquiring and producing information. A selected number of exemplary cases are discussed in order to present current ideas about the technical information needs of students. Another topic analyzed is the information competencies required to be successful as perceived by librarians and teaching faculty. A number of initiatives directed toward collaborative learning or teaching of the competencies needed for success, which are considered important, are presented.

Furthermore, while a general system for technical information has been a topic of discussion for many years, it is also important to determine the main components present in a system of technical communication as it pertains to the educational needs of engineering students. In the process of surveying for information about library resources, needs, attitudes, behaviors, teaching methods and competencies, I will try to identify unique elements that are active participants of this new system of technical information.

Achieving a better understanding of, for example, how engineering faculty interact with librarians, what are the expectations of instructors and the library in terms of information competencies, and what is the role of professional societies in the process of creating guidelines for technical information literacy would be beneficial to better organize programs that would prepare students in technical fields with the necessary skills to manage information effectively. Therefore, by identifying the elements of a system of technical information for students, instructors and librarians no longer will be seen as fixed entities but as part of a dynamic system. A better understanding of this complex system can help in the development of better information literacy programs for students.

## INFORMATION NEEDS, USER BEHAVIORS AND PERCEPTIONS

The literature on engineering education and library and information science contains a great deal about information needs of engineering students and professional engineers. It is clear that not only is identification of resources important but also of equal importance is the perception and the behaviors of students, engineers, librarians and teaching faculty about these informational needs. In this section, an exploration of some of the main topics related to information needs, behaviors and perceptions are presented. The use of technical literature by professional engineers can be a good guide toward achieving educational objectives in the area of information literacy.

A research report about technical communication in the field of aerospace engineering was reported by Pinelli, et al., [1]. In this survey, they found the types of technical information used by plant engineers are: scientific and technical information; computer programs; in-house technical data; technical specifications; product and performance characteristics; government rules and regulations; experimental techniques; design procedures and methods; codes of standards and practices; economic information; and patents. Pinelli, et al. also reported that the sources of technical information used by these engineers are: personal knowledge; informal discussions with colleagues; discussions with experts within the organization; discussions with supervisor; textbooks; handbooks and standards; technical reports; technical reports - government;

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journals/conference papers; and discussions with experts outside the organization.

Almost ten years later, Holland [2] in an article about modeling the training for the engineering information professional, makes the point that the corporate engineering library today is really a virtual library and is an essential part of the desktop work-space. Engineers in this very sophisticated environment can utilize a large number of systems to complete a task. For example, a design engineer can check industrial specifications and the safety of products. They will access information such as reports and business presentations and communicate with others electronically. The work done by engineers is highly collaborative where data transferring is often done between people, departments, and national and world-wide locations. In this environment, the use of electronic technical information is an important tool to master.

Technical information and communication is a subject of significant interest in the literature of engineering education as well as in library and information science. A report written by King, Casto, and Jones [3] in the form of an extensive review of the literature about the use of information by engineers includes bibliographic citations of nearly 500 hundred documents published between 1970 and 1994. This work was contracted by the Council on Library Resources and includes, in addition to the bibliography, the results of several conferences held to discuss issues related to scientific communication in science and engineering. With the development of new information technologies, technical information continues to be a topic of scholarly discussion today.

Stenger, and Goode [4] reported on students usage of technical information. These two engineering faculty members present a case study about research skills of engineering students. The authors report that in a survey done on students in a manufacturing engineering senior project, 75 percent of the students used the Online Catalog, but only 40 percent used databases, and only 8 percent used *Compendex*. Also, only 8 percent frequently used the resources in the University Libraries Web site. In contrast, 90 percent reported using the WWW to find information for their projects.

Current engineering faculty attitudes and practices toward science and engineering undergraduates and their information competencies is surveyed by Leckie, Gloria and Fullerton [5]. This research survey was conducted at the University of Waterloo and the University of Western Ontario in Ontario, Canada. The results show that for students at the junior and senior level, 78 percent of the faculty thought Bibliographic Instruction (BI) was necessary and 69 percent thought it was necessary at lower academic levels. Faculty rated their students' abilities to do library research. Thirty-five percent of upper classmen were rated as satisfactory and 26 percent as good. For the lower level students, 29 percent were rated as satisfactory, 19 percent were rated poor and 48 percent unknown.

The faculty did not know how students improved their information research skills from lower to upper level courses. Fifty-nine percent of faculty said that none of their lower level courses require library research. In upper level courses 83 percent of faculty require library research. The most popular assignments requiring these skills are: short papers, research or design projects, long papers/essays and lab or tutorial reports. The top types of literature they expect students to use are: scholarly journals, monographs, review articles, electronic indexes/abstracts, handbooks and manuals, and government documents. Also, 77 percent indicate that BI instruction given by librarians were useful to their students as it was evident in the quality of their students assignments.

Holland [6] reports studying the information seeking habits of engineering students several years after they attended school. Fifty percent of the responses indicated that 10 years after graduation they where in non-engineering positions such as managers, or in other professions such as business, law, or academia. This survey was given to former students who had taken a formal course in technical communications and a similar group who did not take the course. Those who took the course showed the following characteristics: they were more interested in using libraries (public and college); they had a broader knowledge about technical electronic sources of information (databases, journals, etc.); they read more technical and professional literature; and they spent more time with colleagues communicating information. Only 3.3 percent of all the respondents received information training at their job. This suggests that if training is not given in school, it will never be available to engineers later in their careers. Both groups indicate their interest in learning more about accessing information.

In this section the following elements were identified as part of a system of technical information for students:
engineering and technical information, competencies, technology, librarians and instructors, students, and information skills.

## INFORMATION COMPETENCIES

The importance of identifying a set of specific information competencies is well documented in the literature. In defining these competencies, librarians and the teaching faculty have developed models for information competencies to be used in the classroom; some professional organizations have also been involved in creating competency statements. For example, the Association of College and Research Libraries (ACRL) [7] has produced their Information Literacy Competency Standards for Higher Education, which states:

"Information literacy forms the basis for lifelong learning. It is common to all disciplines, to all learning environments, and to all levels of education. It enables learners to master content and extend their investigations, become more self-directed, and assume greater control over their own learning. An information literate individual is able to:

- determine the extent of information needed;
- access the needed information effectively and efficiently;
- evaluate information and its sources critically;
- incorporate selected information into one's knowledge base;
- use information effectively to accomplish a specific purpose; and
- understand the economic, legal, and social issues surrounding the use of information, and access and use information ethically and legally."

The eight-page document includes a list of standards, performance indicators, and outcomes to satisfy these principles.

This is a general statement but many of its components are in essence some of the competencies expected for engineering and technology students.

The Accreditation Board for Engineering and Technology (ABET) in their *Criteria for Accrediting Engineering Technology Programs* [8], Section I. K.5 states: "Equipment catalogs, professional magazines, journals, and manuals of industrial processes and practices should be readily accessible and used by technology students in addition to the usual library resources. Students should be familiar with the literature of their technology and encouraged to use it as a principal means of staying abreast of the state of the art in their technological field. Library usage is one indication of faculty interest in developing students skills in locating and utilizing information. Library holdings must include a sufficient number of appropriate books, periodicals, reference books and indexes, and standards documents to support the engineering technology programs. Library holdings may be in paper, microform, or electronic formats. Resources owned by the institutions and physically present in the library may be supplemented by other resources, such as electronic information databases and full-text document delivery systems..."

The ABET statement concerning libraries for engineering programs is stated in more general terms as is indicated in Section 6. Facilities of the *Criteria for Accrediting Engineering Programs* [9]: "Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of students and faculty and the educational objectives of the institution."

Along these lines, Laherty [10], has presented an interesting comparison of ACRL standards with the National Science Education Content Standards. The author shows a strong correlation between these two standards and suggests that a partnership between teaching faculty and library faculty can provide a variety of solutions appropriate to specific subject matters.

Libraries are also expressing the desire for competencies for the students they serve. Franks, Hackley, and Straw [11] describe the work done by the staff of the University of Akron Library to create an interactive Web tutorial to teach information competencies. This article also includes, as an Appendix, the Library's Competency statement. The statement is a two-page document giving a detailed set of core competencies for students to master in six major areas:

- recognize and articulate an information need,
- identify and select appropriate information sources,
- develop and use successful search strategies,
- locate and retrieve relevant information in a variety of formats,
- critically evaluate the information retrieved, and
- use information in a cohesive, logical, and ethical manner.

In a 2000 ELD-ASEE award winning paper Lin [12] proposes a new core of information competencies. This is based on the author's perception of what is included in the education of engineers. The author identified the following elements: technical expertise, product development, marketing, financing, creativity, communication, and serendipity; information is the foundation of all of them. This variety of elements implies a complex core of information competencies. For this purpose, the author proposes the following core of information competencies:

- ability to acquire and interpret information,
- ability to manage information,
- ability to communicate information,
- ability to apply information to specific tasks and innovate,
- ability to apply the above competencies in international and cross-disciplinary contexts.

Finally, the author concludes that there is a need to move librarians from being library instructors focusing on just library research skills to "information educators" with a broader base of responsibilities.

In the 2001 ASEE award winning paper Nerz and Weiner [13] present the need for implementing curriculum-integrated instruction to teach information competency skills to engineering students. The authors state that in course-integrated instruction students do not seem to retain the skills learned or can not apply them to a different situation. For Nerz and Weiner: "True curriculum integration means that information skills are deeply embedded across the curricula; instruction in information skills should not be so prevalent that students aren't aware it's happening. Such a program requires taking a strategic or system-wide approach to information literacy ... ."

Based on Lin's [12] ideas about information competencies, Nerz and Weiner go about designing a four year program and identifying specific competencies for the freshmen, sophomore, junior and senior years level. This is supposed to be a strategic program where students gradually increase their skills and knowledge about technical information.

Competencies have also been identified at specific course levels as reported by Stenger and Goode [4] in their class projects oriented toward improving the research skills of their students. In their class, they expect students to learn about the information resources available on the Library Web site conducive to their design projects; to learn to plan search strategies; and to learn to evaluate the information found in both the Library and on the WWW.

Integration of core competencies into a curriculum is presented by Ohles and Maritz [14]. In this case, faculty from a physical therapy associate degree program identified a number of competencies to be acquired by students during the two years of their associate degree program. Assimilation of these skills in an incremental order, semester by semester, is expected. E-mail proficiency, introduction to electronic mailing lists, introduction to online database searching, World Wide Web searching, and Library research are the main components of this integrated and collaborative program. Again, the goal is to provide students with life-long learning skills for their careers.

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engineering and technical information, professional societies, competencies, students, and information skills.

## INITIATIVES ENCOURAGING COLLABORATIVE TEACHING OR LEARNING

Information competencies for engineering students have been achieved in many different ways. Some programs are well structured and formalized in the course work. There has been good consensus throughout the years that information skills will help students in their projects, and these skills will later become a good asset to them as career engineers. Some of the approaches to fulfill the teaching objectives are presented here.

In the program set up by Stenger and Goode [4], the authors found it appropriate to set aside time for two in-class workshops. The first covers library resources and search strategies. The second workshop, given in the next class period, covers further discussion on searching databases, followed by WWW search strategies and evaluation of the information found. This exercise represents a typical instructor/librarian teaching collaboration where the team works with students in learning about resources, searching methods, and information evaluation.

As mentioned before, an example of course-integrated instruction is taught by Nerz and Weiner [13]. In this case, students must develop a pathfinder on industrial management issues. This is a six weeks project that provides the opportunity for a great deal of interaction between the students and the librarians teaching this portion of the course. It is also a good example of a cooperative librarian/instructor collaboration.

The curriculum-integrated plan for information competencies proposed later by the same authors have four levels. Freshman level: Locating information. Sophomore level: Finding, locating, analyzing, and synthesizing information. Junior level: Finding, identifying, evaluating, and synthesizing information. And, senior level: Synthesizing and evaluating information.

Fjallbrant and Levy [15] describe a training program, called DEDICATE, for information literacy for distance education that took place in several European universities. The purpose of this project is to develop online courses to teach information competencies. Although its motivation is to train information specialists, this model can be adapted to train students taking distance education courses in engineering and technology. The five units of the program are: The Internet as a learning environment; Search for information in a selected specified subject area; The institutional context; The design of an information literacy course; and Learning review and course review.

An example of intensive participation of librarians working collaboratively with students on a senior design project is discussed by Weiner [16]. In this particular case, the librarians involved in the project worked as team members, participated in lab meetings, helped students in creating strategies for gathering data, and helped them to identify important sources. Information on marketing, companies, machine specification, patents and existing similar products is provided. This is a semester long project and the librarians in a very proactive posture assist the teams in collecting this massive data. Their goal is to show future engineers the importance of information professionals and how they can be of help in their project goals.

Instructor and librarian collaboration in a design course at the Queens University of Technology is reported by Bruce and Brameld [17]. The purpose of the project is to improve the quality of student reports particularly in the area of literature reviews for their design projects. Four hours of library instruction is spent teaching students about different searching techniques, sources and strategies; two additional hours of support are provided beyond the instruction. The librarian was able to brief all projects supervisors about the nature of the library research instruction given. Students were required to give details of their library research in their projects logs. Students were also required to give presentations about the results of the literature reviews of their projects. Librarians participated in these presentations and helped to evaluate them. Finally, librarians were invited to the students' final report presentations. A substantial improvement of student use of information resources was observed as was improvement in their final written reports.

Collaborative efforts are also present in the form of courses on scientific writing. Huertas and McMillan [18] discuss a collaborative teaching project on scientific writing. It is taught as a two-course sequence for students in health and natural sciences. The first course is for freshmen; the second course is for juniors or seniors. One of the instructors is a librarian; the other is a writing instructor. Both instructors are equally responsible for teaching and student evaluations. The aim of both courses is to prepare students to write a review paper about a scientific topic. It is not the scope of this paper to present in detail the coverage of these two courses but some of the elements included are: writing workshops; portofolio development; peer reviews in an attempt to simulate the process of scientific writing; individual conferences with students to identify library research and writing abilities; and students self-learning and time management.

Courtois and Handel [19] report about a teaching collaborative approach to teach genetics information. This was an instructor-librarian team approach in a fifteen week period with six sessions assigned to teaching bioinformatics. The emphasis is on teaching and assisting students in achieving a good basic knowledge of basic electronic communication, advance *Medline* strategies, major bioinformatics sources related to human genetics, and evaluation of research findings. The librarian also participated in designing bioinformatics assignments and evaluating this part of the course.

Ohles and Maritz [14] use a learning collaborative approach to teach information skills and resources. In this case, students work in groups to complete the assignments and to attain the set of expected competencies. These assignments are in the form of in-class group exercises and group written research papers. This program assumed a close collaboration between librarians and instructors.

Finally, Holmes, et al. [20] present their experience with a large-enrollment course. In this case, librarians and engineering faculty have developed an interactive library instruction model. The class is divided into small groups, each group works on specific assignments and the instructors serve as facilitators. At the end each group makes a presentation of their findings. This team approach emphasizes collaborative learning and is an integral part of the course objectives.

In this section the following elements were identified as part of a system of technical information for students: engineering and technical information, competencies, teaching strategies, technology, librarians and instructors, students, and information skills.

## CONCLUSIONS

The results of this survey show that engineering and technology students are confronted with a significant number of information resources that they should master in order to be successful in their programs. It is also noted that people's behaviors and perceptions about information needs are worthwhile to take into consideration when designing library instruction for engineering students. In addition, the survey shows how some professional societies, libraries and faculty members are interested in identifying technical information competencies for engineering programs. Also, there is a vivid interest on the part of librarians and engineering faculty for creating collaborative teaching and learning programs.

The following components directly related to technical information education have been identified as part of a system of technical information for students:

- there is a well defined body of scientific and technical information;
- sets of information competencies have been identified;
- a number of teaching strategies have been explored successfully;
- teaching faculty and librarians are working together;
- students are the population to serve;
- there are professional societies involved in the many phases of engineering education;
- there is very robust technology to be used as a tool; and finally,
- there is a goal: students ought to master some basic information skills.

FIGURE I

SYSTEM OF TECHNICAL INFORMATION FOR STUDENTS
COMPONENTS AND LINES OF INTERACTIVITY

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          Engineering and Technical Information-------------I
                I           I        I              I
                I           I        I              I
                I           I        I              I
Professional----Competencies-------------Teaching--------------I
Societies       I           I     Strategies        I
  I             I           I        I         Technology
  I             I           I        I              I
  I             I           I        I              I
  I-------------Librarians and Teaching Faculty-----------------I
                            I                       I
                            I                       I
                            I                       I
                         Students-----------------------------I
                            I
                            I
                            I
                        Info. Skills
```

Figure 1 above includes all the aforementioned components. As is evident through this survey, this is supposed to be a dynamic diagram where each component has a definite role and where different components are interacting to obtain the best results. For example, teaching strategies might be directly related to the technology being used, the kind of information to be analyzed, and the set of competencies expected. Feedback from students' experiences can be beneficial for the planning done by instructors and librarians, and students feedback can be an influence on selecting new teaching strategies.

As suggested in the introduction, it is important to maintain a continuous dialog between the components of this system in order to better organize programs that would prepare students in technical fields with the necessary skills to manage technical information effectively. Finally, a topic that was not covered in this survey but that require some further analysis is the extent which engineering professional societies (ie., IEEE, ASM, etc.) should be actively involved in identifying information competencies for students in their field.

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