

# Training Future Engineering Students to Information Literacy: a Challenge for Academic and Professional Success

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*Abstract:* - Information literacy in the present era, which is characterized by the multitude of information sources, information explosion, and the rapid development of information technology and communication, has become a must for the effective use of scientific and technical information for both academic and professional success. This article focuses on information literacy of future engineering students. It presents results of a study conducted among a sample of students who reveal shortcomings and gaps in information retrieval in this category. It then proposes ways of intervention for engineering schools in order to facilitate the development of these skills in the academic community.

*Key-Words:* - Information Literacy, engineering students, information competency, academic librarians, training program, higher education.

## 1 Introduction

There is no doubt that information literacy has become one of the major elements of the development of knowledge society. The proliferation of information resources, the focus on lifelong learning, and the requirement for highly skilled persons have highlighted the need for information-related competencies. Indeed, Information literacy "is common to all disciplines, to all learning environments, and to all levels of education." [1] Information literacy competency is highly important for students in science and engineering/technology disciplines who must access a wide variety of information sources and formats that carry the body of knowledge in their fields. These disciplines are rapidly changing and pose unique challenges in knowing how to keep up with new developments and new sources of experimental/research data [2] because currency is particularly important in such fields, it is essential that students access the latest information in their own and related fields. Thus, in the center of information literacy, as defined by UNESCO, there is education to information; i.e., the "ability to acquire informational culture." [3] This emanates from a simple question: how to train to use and control information? Such training is supposed to

take place before university; however, we know that this kind of education is far from being systematic.

In fact, actors of information society, including students, use information constantly in all its different forms. More specifically, engineering students need to apply those skills to "identify the need for information, procure the information, evaluate the information and subsequently revise the strategy for obtaining the information, to use the information and to use it in an ethical and legal manner, and to engage in lifelong learning." [2] However, these actors are far from knowing how to exploit to their maximum the potential tools and research instruments, either at the level of their studies or during the performance of their professional duties. Unfortunately, the students' real level of information literacy at the beginning of their studies, has never been assessed. Thus, we have decided to organize a study aiming at describing this initial level of information literacy, at identifying the students' main weaknesses, as well as allowing instructors to adjust their training on this basis.

Indeed, the concept of information literacy, which we present in the next section, is a promising asset for both students and teachers in higher education. So, the question is how to sensitize on the one hand future engineers to master information processes, no

matter what tools they can use, and on the other hand responsible of engineering training to the importance of this learning ? What strategy to implement in order to realize a training program for the use of information in an academic context? This article targets the engineering community in particular, the specificity of its business practices, their need for information and documentation. In sum, the pedagogical perspectives for an integration of training in information literacy, be it basic or continuous in the general curriculum. First, teaching issues dealing with information literacy, as well as the different terminologies present in this context will be presented. Second, the results of the study, conducted among a sample of students in first-year engineering, dealing with their documentation practices and information literacy will be analyzed. Finally, some guidelines and courses of action for the establishment of a training program to master information on behalf of the university community will be proposed.

## 2 Teaching Issues in information literacy

The current era is characterized by a predominance of information in all aspects of individual professional and social life. The engineer is clearly at the crossroads of the exchange and dissemination of specialized information of all kinds. This reality is at the heart of his daily practices. In professional situations, he is brought to seek information that he should evaluate, validate, produce and disseminate; so he must master that specialized information. As part of his activities, the engineer realizes various projects and plans; he also carries information, sells his project or defends it; he tries to convince other partners and decision makers. In this regard, it is clear that to do his job as an engineer, he must be equipped to manage the flow of information effectively [5]. In fact, the knowledge and expertise of engineers become assets that can no longer be neglected. Therefore, the development of these skills must be taken into consideration since university, or even since school. Research and validation of information, promotion and transfer of knowledge production and dissemination of specialized information are all areas to focus on within the framework of what is called information literacy. In this context, the training of students has become a major issue in higher education institutions. Indeed, this informational evolution must necessarily be accompanied with a mastery of

new tools and a rational appropriation of information. Thus, when teaching information literacy to students of science, no matter their academic level, it is particularly useful to provide the context of science and scientific literature, and to provide concrete examples and tools from the appropriate discipline. More generally, students need to build their knowledge and acquire skills relying primarily on courses by their teachers, but also increasingly sort through the mass of information available to them, and learn how to validate and process it appropriately. The debate about the usefulness of the training for the use and control of information is not new. It seems that in this area, many foreign countries such as Australia, Canada, France, etc. are more advanced. Training future engineering students to information literacy namely prepare them to learn and document effectively, both in their study and in their future professional life, is the objective that all program managers in engineer training should absolutely consider in this early 21<sup>st</sup> century.

### 2.1 Information literacy, information culture, information competency, information skills: terminology clarification.

In the Anglo-Saxon literature, "Information literacy", "Information Culture", "Information competency", and "Information control", all mean "information literacy." This refers to a competence: "Being competent in the use of information means knowing when there is a need for information, and being able to find the adequate information to assess and exploit. Information literacy is a survival skill in the Information Age. Instead of drowning in the abundance of information that floods their lives, information literate people know how to find, evaluate, and use information effectively to solve a particular problem or make a decision [5]. The term information literacy was used for the first time by Paul Zurkowski, president of the Information Industry Association (IIA) in 1974 to describe the "capacity of employees to use information wisely, using the right sources and the best techniques to get to their goal." This initial vision is biased towards private sector but does not exclude training dimension [6]. Since then, the concept of information literacy has grown to include multiple definitions, models, standards and best practices. "*Culture*" or "*mastery*" of information (*information literacy*) could be defined as a set of skills to identify what information is needed and to locate, evaluate and use the piece of information found in a problem-solving process leading to communicating

*the retained and processed piece of information. This set can also be presented as a series of skills allowing the individual to survive and be successful in the information Society". [...] It is one of the "five essential skills" to integrate the labor market in the future."*[7]

In any domain of research, a person, without learning, cannot use relevant information and adopt an effective documentary approach. These are skills that are acquired and for which educational institutions (schools and universities) have an essential role to play. They are not an end in themselves, but an inevitable way to access other skills and finally fit effectively in the information society.

## **2.2 Why train students, future engineers to master information?**

Engineering is a field that is fast developing as a result of scientific and technological advancement. Previously, it was clear that training institutions were the only access to specialized information source. But today, it is no longer the case, since everyone can have access to any piece of knowledge, even data from the other side of the planet.

Indeed, users' behavior and needs in documentary information vary greatly depending on their education and professional practices. Training in information is in part a "trans- disciplinary" activity [4] whose aim is to highlight the virtues of documentary practice in the acquisition of knowledge, and therefore, enhance the fundamental part of information in teaching different disciplines. As a matter of fact, the tools and methods of information retrieval are adapted to the nature of the disciplines in question and the information they generate. In this context, it is essential to adapt the training to the use of information according to each specialty. Today, a big number of achievements and experiments in the world not only in developed but also in developing countries, clearly show that the training of engineers in the control of information is of paramount importance [4]. All their activities fit into a perspective of informational resource development, genuine backbone of industry and modern services. Thus, engineering students need to be equipped with strong information literacy skills to succeed in their academic and future professional goals. In fact, it seems imperative to help future engineering students to learn to better control their own access to information and knowledge systems; i.e., manage their own approaches to processing and communication of data or documents, or, in other

words, to decide on a "quality" process in the management of their information and documentation for their training. [4] The Strategic control of specific information is the essential skill that engineers must possess, if they want to fulfill their role as operators of change in society. In short, information literacy seems essential to the future employment of students.

## **3 Presentation of the study**

There are many studies that have focused on engineering students, different aspects of the subject were discussed, and for instance, Pauziah et al. have investigated in [11] the female academic performance of Electrical Degree students at the Faculty of Electrical Engineering ; Dondon, in [12] has discussed the question of sustainable development and "human being teaching" in a scientific engineer school. In this paper we focus on another aspect concerning engineering students, namely information literacy in a context of engineer school.

This study is aimed at a specific population: future engineers.

### **3.1 Background, Objectives and Methodology**

This study is the result of a research group work from different disciplines (information science, computer science, etc.). It seeks to assess whether students entering the first year of engineering schools have the documentary knowledge and skills required to easily perform research projects as part of their studies: the research may include additional courses, research projects, internship, independent study, personal research. In other words, are they adequately prepared to integrate a higher education school armed with working methods and documents retrieval skills? This study does not claim to be exhaustive. A total of three institutions, namely the Mohammadia Engineering School, The National School of Computer and Systems Analysis and the School of Information Sciences have been the subject of evaluation and study. The study was limited to a representative sample of 253 students, which led to a significant rate of responses, namely 92.89%.

The hypothesis advanced was students in this cycle present difficulties and limitations in working methods and documentary research. If that was the case, it seemed important to make the research process more efficient for students and this by

accompanying them through a training that helps them upgrade their information skills. In that sense, some recommendations are brought to light for all actors contributing to the improvement of student success in higher education, based on the international standards [1, 8], namely those of the ACRL (Association of College and Research Libraries), and practically standards in relation to science [2], published in 2006. A higher studies student is assumed to have acquired a certain amount of autonomy and logical use of the different tools at his disposal whether it is a library, university, e-learning platform or database etc. The table below outlines the five ACRL standards in relation to science, and Engineering/Technology.

Standards	Characteristics
1-Identifying the need for information	The information literate student determines the nature and extent of the information needed.
2-Procuring the information	The information literate student acquires needed information effectively and efficiently.
3-Evaluating the information, revising search strategy, obtaining more information	The information literate student critically evaluates the procured information and its sources, and as a result, decides whether or not to modify the initial query and/or seek additional sources and whether to develop a new research process.
4-Using the Information and using it in an ethical and legal manner	The information literate student understands the economic, ethical, legal, and social issues surrounding the use of information and its technologies and either as an individual or as a member of a group, uses information effectively, ethically, and legally to accomplish a specific purpose.
5-Engage in lifelong learning	The information literate student understands that

	information literacy is an ongoing process and an important component of lifelong learning and recognizes the need to keep current regarding new developments in his or her field.
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Table 1: Synopsis of the Standards

### 3.2 Results and Analysis

An important step in information literacy development is to obtain data on students' abilities. These data will indicate areas of improvement and the most appropriate training and services required. Data for this study were obtained using the questionnaire. The standards published by the Association of College and Research Libraries (ACRL) were used to identify 5 themes on which the survey is based.

Themes	Specific knowledge of the skills addressed by the questionnaire
Identification of the need for information	-Identifying and/or paraphrasing a research topic -Consulting an instructor/advisor for appropriateness of topic, research project, etc. - Developing a hypothesis or thesis statement and formulates questions based on the information need
Search Strategy	-Selecting the most appropriate investigative methods for accessing the needed information. - Developing a research plan appropriate to the investigative method - Uses various relevant search systems to retrieve information in a variety of formats - Using specialized online or in person services as needed to retrieve information
Information evaluation	- Selecting information by articulating and applying criteria for evaluating both the information and its sources - Examines and compares

	information from various sources in order to evaluate reliability, validity, accuracy, authority - Evaluating the procured information and the entire process
Search tools	- Distinguishing between primary, secondary, and tertiary sources - Utilizing computer and other technologies (e.g. spreadsheets, databases, multimedia, and audio or visual equipment) for studying the interaction of ideas.
Use of results	-Knowing what a bibliography is. -Recognizing the type of document that corresponds to a bibliographic reference. -Knowing when to include a reference to avoid plagiarism. - Identifying the different types of plagiarism

Table2 Information literacy skills addressed by the questionnaire

Based on the questionnaire responses, the percentage of students who correctly answered every question in each information literacy theme was analysed descriptively using the statistical package for the social sciences software (SPSS). SPSS is used widely by education or health researchers, survey companies, government and others for their statistical analysis.

Our analysis of responses to questionnaires administered to students helped unveil a number of documentary practices. Indeed, respondents are aware of the main steps of a documentary review, including identification of their information needs, defining research objectives, evaluation of information sources. However, in practice, the implementation of these steps is modest as illustrated by the figure 1:

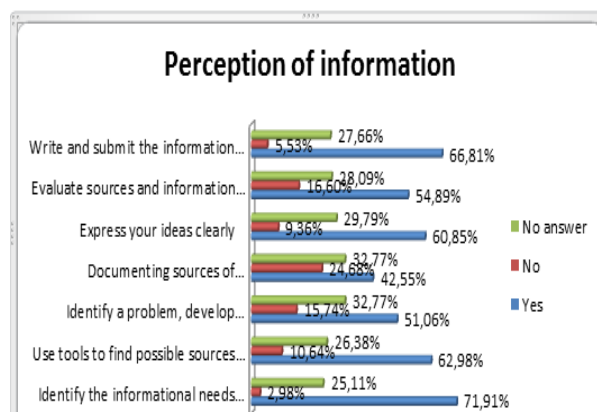


Fig.1: Perception of information respondents students

As illustrated by the figure 2, the tendency of most respondents was the use of electronic sources as the percentage shows: 57.87% wiki, 64.26% blogs, and social networks 59.57%.

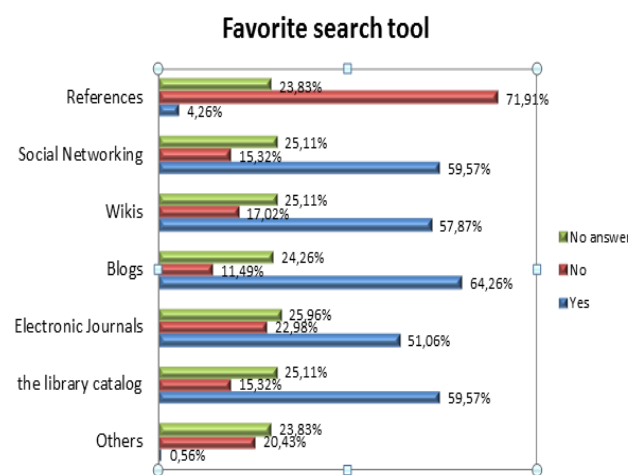


Fig.2: Student' favourite search tool

This could be explained either by the ease and availability of these sources, or by the lack of knowledge of the importance of other sources. As far as the perception of information and research are concerned, shortcomings and deficiencies could be notices especially in terms of access to information, at the level of research methodology and at the presentation of information. This can be justified by the small percentage of the degree of ease of perception of the process of information retrieval, including problem identification, content development, testing a hypothesis (8.05%), and assessment of information sources (8.47%) as well as writing and presenting the retrieved information (18.64%). It was also found out that very few students use the library (only 16.6%) and scientific

journals (25.5%), they prefer to access information through electronic resources such as e-books (60.8), social networks (40.43%) and wikis (47.6%), especially because of their quick results.

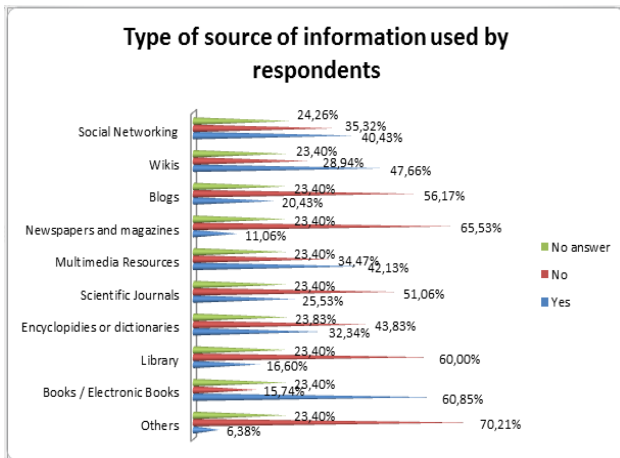


Fig.3: information sources used by respondents

Their ignorance of other research instruments then generates a research behavior that makes them use spontaneously the research tools they know best, or they think they know best; totally neglecting other tools at their disposal, that would certainly make their research more efficient. But the question arises whether they really have the skills to properly discern valid information within this mass of information? One question in this matter revealed a high rate of non-response concerning the relevance of information (specialization of the editor, arguments advanced by the author, time and freshness of the piece of information and the adequacy of information to their needs). This could be explained by a lack of knowledge of information evaluation techniques. As for respondents, the level of assessment of these criteria remains low. That said, it should be noted that a percentage of 55, 74% of respondents insist on checking the suitability of the information to their needs. The figure below shows the percentage of students respecting the criteria that should be considered when evaluating information.

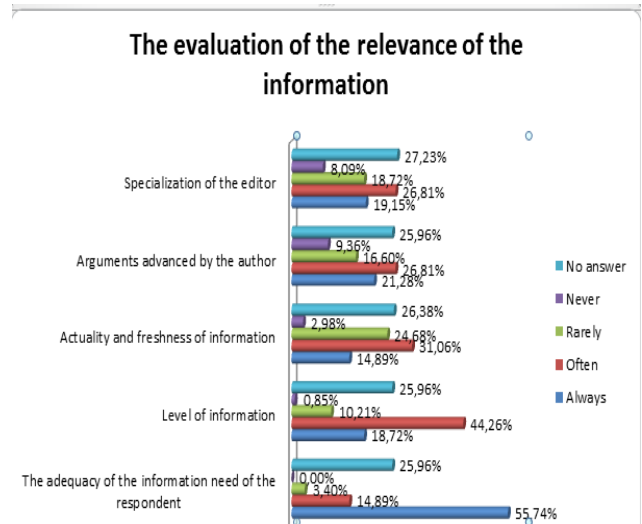


Fig. 4: Criteria used to evaluate information

It would be wise to enhance their learning of information literacy that could help them acquire the technical evaluation of information sources to improve the results of their research. Our study has shown that ignorance and / or under-utilization of various reliable information sources (databases, scientific journals, library catalogs, reference books ...), in addition to a lack of an adequate methodology of research, negatively influences students' research practices. Finally, as illustrated in figure 4, many students recognize their lack of knowledge retrieval and express a desire to participate in workshops and / or training in information literacy.

Utility to do a training course to improve knowledge and skills in information retrieval

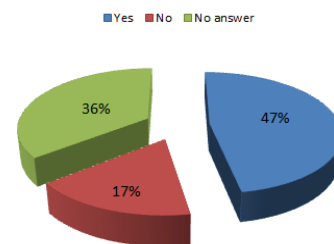


Fig. 5: Utility to do training course in information literacy

The students' rather poor results confirm that organizing an information literacy program is imperative if students are to perform well in their studies. However, 36% of students did not respond to this question and this could be explained by the

lack of knowledge of the importance and value of information skills in the information society.

#### 4. Proposal for a Training in information literacy

Information literacy is a teaching-learning process which is based on the principle of "know how to get informed" and "know how to learn" throughout life. Indeed, thinking about the establishment of a training program in information literacy is more than ever the agenda of universities, especially at the international level. So, many questions arise as to the objectives of these classes and the conditions of their applicability. First of all, such training must be examined in its context and must specially be adapted to the informational needs of the future engineer. It is therefore necessary to analyze and understand the information needs of engineers, needs related to their daily professional practices, before putting in place training programs that are irrelevant or inappropriate.

##### 4.1 General principles for the establishment of a training program on Information Literacy

This section discusses and clarifies the content likely to train students in information literacy, and helps them acquire informational culture. But before going further, it should be noted that it is important to think in terms of strategy, and not only in terms of tools or means, no matter how sophisticated they could be. This education will certainly be conditioned by the choice of the model considered (engineer-technician, engineer-scientist or engineer-manager). The Objectives and training programs to information differ quite significantly.

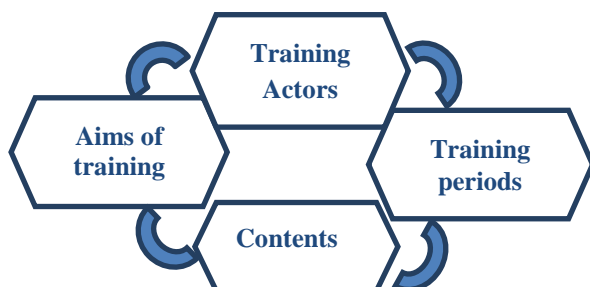
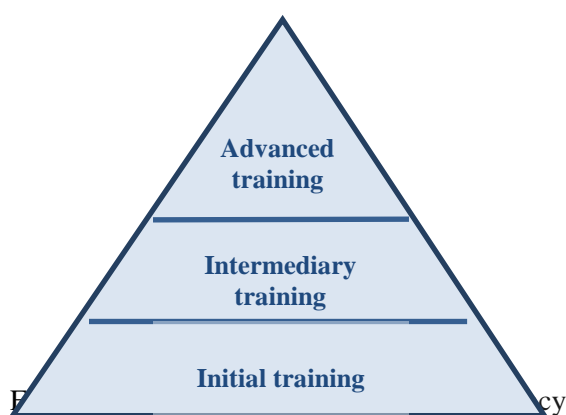


Fig. 6: Setting up a training program strategy

Establishment of a training program in information literacy should be based on needs, demands or identified statements of dissatisfaction, particularly from studies done. The purpose of such teaching should be fixed in advance (self-learning, academic and professional success, etc.) and the training program must be conducted in different phases. Indeed, during the first phase of engineering studies, emphasis should be placed on sensitizing students to the main points of documentary references, information resources and existing documents; learning how to write references, becoming familiar with the existing research instruments, etc. At the end of this curriculum of initial training, the student is now confronted with a very open field of new knowledge to discover and fathom, with disciplines more complex, mixing scientific foundations, technological developments and professional practices; hence, the need to rehabilitate the pedagogical strategies by targeting mainly the activities that are likely to prepare the engineer to face real life in the company or on the ground. This period needs more advanced methodological programs, based on more advanced search for relevant and useful information, and in particular, on the consultation of professional or specific databases. During this period, the training program will focus on the work of synthesis and critical reading of the collected data, communication and presentation of information, and approaches leading to problem solving. We add to this, training on the concepts and practices of technological or strategic monitoring, access to information methods, issues related to copyright and intellectual property, standardization and protection of ideas, etc. These proposals are not exhaustive, for each institution may, of course, define more specific content, taking into account the specialty in play. In sum, training in information literacy should be fully integrated into the training curriculum, and gradually adapted to the level and direction of studies. The training program can be divided into different phases as follows:



The training program must be developed on three levels; the first level consists of basic skills, introduction to information literacy, issues, sources of general and specialized information, etc. Every discipline is unique in its information source framework. It is essential to give students such a framework so that they can organize the sources that they encounter in a way that makes them useful for solving subject-specific problems. These are activities to promote students awareness of the importance and usefulness of such training for their academic success and their future careers.

The second level, in the middle of the training period, will focus on the documentary research methodology in specialized fields of study. Among its goals is to familiarize students with the tools and techniques of documentary research, the modes of access and processing of information, the techniques of presentation and communication of information, etc.

In the third and final level, it is to complement the training to information initiated in the first two levels. The training objectives tend to focus on professional issues, because it is important to prepare future engineer students to professional integration, by giving them the necessary knowledge to process and use information in a competitive world, especially preparing them for specialized production and communication. In addition to that, such a system must be part of a *conscious* and *purposeful* educational policy with the support of many players, internal or external to the institution of higher education (principals, teachers, information and documentation professionals, library and technical university managers, working engineers, engineering organizations, etc.). It consists of a set of tools that covers several functions: collective work (groupware); sharing files; production and dissemination of educational materials, etc.

Level	Learning Outcome
<b>Initial training</b>	<ul style="list-style-type: none"> <li>-Introduction to information literacy, research methods</li> <li>- Examine the different types of information sources (e.g. Library Catalogue and a multidisciplinary database).</li> <li>-Distinguish between primary and secondary resources in engineering field; determine when it's appropriate to use these types of resources and why.</li> </ul>
<b>Intermediary training</b>	<ul style="list-style-type: none"> <li>-the documentary research methodology in engineering field</li> <li>-Differentiates types of publications from scholarly, popular, to professional periodicals through their content and audience, demonstrating skills in how to access them.</li> <li>- Resource evaluation as critical thinking</li> </ul>
<b>Advanced training</b>	<ul style="list-style-type: none"> <li>- Using appropriate search methods to access a variety of information sources applicable to the discipline</li> <li>- understand different types of bibliographic citations</li> <li>- create, preserve and communicate knowledge</li> <li>- identifying emerging forms and methods of scholarly publishing in the field</li> <li>- Using technologies for keeping current in the field</li> </ul>

Table3: Training program levels

Learning results need to be measured so that the learning outcomes and instructional activities can be



adjusted accordingly. In other words, outcomes assessment determines how well students obtain the knowledge and skills taught in the different sessions. It should be noted once again that librarians and instructors should work together to identify the best way to embed information literacy training into disciplinary curricula, as well as to make the training relevant and meaningful.

Besides the strict provision of means of access to information resources, institutions responsible for engineers training must work together to enhance their training curriculum of pedagogical contents allowing student to have access to methodologies of collection, processing, storage and dissemination of relevant information, while taking into account the specific problems of information engineering. Also, they need to establish procedures to consolidate knowledge in constitution (practical work, personal or group projects, educational exchanges, tutoring,), without neglecting, of course, the evaluation of this work. It should be noted that information and documentation professionals present in higher institutions, can provide effective support to training in information literacy. They may, in consultation with the faculty, intervene at different levels: visiting the library, introduction to the documentary research, training in the use of the main documentary tools, orientation in the use of the services of the library and information resources and documentaries that students will have to use throughout their career etc. In addition to that, an important aspect should be given to the training, the use of some few useful tools from the information science discipline for engineers, especially information systems, statistical or probabilistic methods applied to information, technical documentation and content management.

#### 4.2 Training for what skills ?

In the present era, like illiteracy, the inability to get information has become a handicap. The problem is not the information flow, for it is everywhere. The problem is that the cognitive ability to access and treat this information are unequal; hence the need to acquire and develop skills to handle the ubiquitous information through participation in community life, source of knowledge and power, but also the ability to transform this information into decision. This set of information literacy, which is part of the logic of professional information management and which is useful to the engineer, ensures his integration into the information society.

It is essential to make it clear to prospective engineering students that the sources of information

are not limited to the university library or school; they are inevitably a part of the huge deposit information resources and documentaries, in which they will have to draw throughout their careers. Professional engineering organizations, businesses, engineers practicing etc. all provide a valuable source of expertise to use. Moreover, the proposed content must reflect the actual needs of information. These concern more the problems of managing complex information environments than strict proper handling of references. Information literacy also means an efficient and intelligent management of the important information flow; namely, evaluation and selection of informational solutions, development of professional environment information which is adequate to the professional environment in which engineers will have to conduct their business. In fact, information literacy training should not have to persuade students to use the library for this purpose alone, but must make them aware of the issues and potentials of a good knowledge of information processes [2]. In sum, information skills that should be developed by engineering students include three basic components: access, evaluation and use of information. [8]

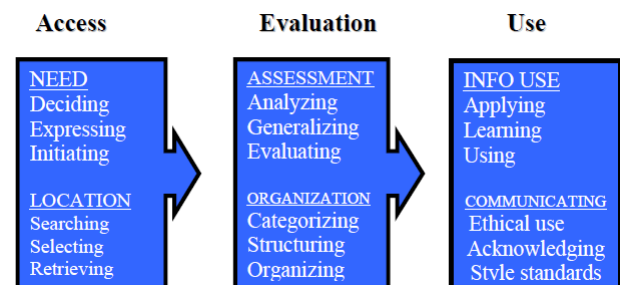


Fig.8: Information skills

#### 4.3 Train in Information Literacy: What pedagogical approaches to advocate ?

The choice of a teaching method or another depends on several criteria, including available means via locals and teachers; but also by the number of students and length of training, etc. For better efficiency of such a training, we must mobilize more actors (teachers, university librarians, directors, etc.), but it also means giving up conventional teaching techniques and adopt more constructive methods integrating knowledge and expertise. In order to succeed in this business of training in information literacy, we must opt for approaches that motivate students and develop their

independence and encourage their imagination and critical thinking. For instance, we can cite project-based learning or case study that requires problem-solving approach and therefore the use of relevant information.

Furthermore, collaborative and team work enhances students' motivation and encourages collective research and information sharing as well as data exchange using modern technologies. Similarly, cooperation between information specialists and teachers should be systematically favored [9]. Integrating Information literacy across curricula is an opportunity and challenge for both faculty and librarians. To achieve a continued and significant impact, IL cannot be addressed only by librarians or only in isolated experiences. Instead, we need a global approach through which invested campus partners (professors, administrators, and librarians) come together and advocate for the importance of IL and accept shared responsibility. Trainers monitor and coordinate activities, guide learning, provide timely lessons that students need by linking knowledge and methods. Furthermore, practical guides, pedagogical modules and materials can be made available to students in different forms, in-class or in distance. Additionally, the library provides an environment conducive to scholarly research and study. It is the principal campus resource whose support by the university exemplifies its commitment to educational excellence. In this sense, the contribution of librarians in the information skills development is vital [9].

## 5 Conclusion

This study reveals, on the one hand, the lack of awareness among students on the importance of developing good information skills and on the other hand, it identifies the information literacy skills that engineering' students need to improve on. These include identifying the most efficient search strategy, evaluating information and its sources, using information ethically and legally, as well as keeping current regarding new developments in their field.

The acquisition and continued development of information skills will undoubtedly allow future engineer students to build gradually by themselves their own know-how in information resources to manage and evolve throughout their working lives. This accountability in building knowledge bases and know-how seems to be crucial in a new perspective

on the role of the technical and economic engineering mediator. It is an asset that cannot be ignored or sacrificed by lack of awareness or experience. Similarly, it is important to note that these informational skills are at the base of training throughout life, they are "common to all disciplines, to all learning contexts and at all levels of education», and students could develop these skills by themselves eventually, i.e. "learning by doing". Develop these skills it also responds to an issue of citizenship in the information society. [10]

In conclusion, information literacy should be considered an essential and integral component of higher education and training of engineers. The exchange and sharing of specialized information, the production and communication of content, the enhancement and knowledge management, are all areas to focus on in the context of this documentary learning for effective action.

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