Critical Assessment of the World Wide Web as an Information Resource in Higher Education: Benefits, Threats, and Recommendations

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Abstract

The resources provided by the Internet and in particular the World Wide Web are considered to be extremely important in higher education as it moves towards a learner-centered approach. However, the use of the Web presents a series of problems and drawbacks that need to be carefully analyzed before being used in a classroom environment. This paper reports on our experiences in the use of the Internet in Engineering and proposes methods for its appropriate use in higher education in technical fields.

Introduction

Today's high-tech environment has also permeated into higher education as ever newer technology is being pushed inside the classroom as the most appropriate teaching and learning tools. This fact reminds us of the first days after the telegraph was introduced in the USA and the subsequent decline of newspapers. At that time, the critical issue was how fast words could be transmitted without giving any consideration to the importance of the message being sent (Postman, 1986). Something similar is happening today with the use of the World Wide Web, in particular with generic search engines such as Google, Yahoo, etc. It may be easy to believe that the always accessible, high-speed, and vast array of information sources is also valid and reliable tools. However, this is not necessarily true. In fact, we believe that in order to give the World Wide Web the teaching value

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that it deserves in higher education, it is first necessary to show and analyze all of its possible drawbacks.

We are also aware that our current students feel extremely comfortable with computers, perhaps more than earlier generations of students felt with printed media and libraries. However, this level of familiarity does not equal *computer literacy* and may pose a threat to their intellectual development through a series of hard-to-break bad habits that they may have acquired earlier. Therefore, we believe that additional educational goals for all faculty members in engineering and engineering technology have to focus on helping students understand the potential and the limitations of using Internet resources for their educational requirements.

We have observed a global effort to move the educational approaches in Engineering and Engineering Technology towards active learning and student-centered activities. The European Convergence Education System that resulted from the Bologna Agreement (Nyborg, 2004) as well as the Accreditation Board for Engineering and Technology (ABET) in the United States have been stressing for several years how critical these approaches are to the full development of our Engineering and Engineering Technology students. Although we fully agree with this principle, we have also observed that faculty struggle to implement these learning activities, resorting in most cases to making students search for information on specific subjects. Students tend to use the Web as their only tool to search for this information without any further analysis of quality, veracity or possible bias of the information, thus limiting a wider understanding of the subject matter.

The aim of this paper is to report our experience on the use of the Internet as an information resource in engineering and engineering technology. The paper emphasizes the problems that we have found, assesses the potential benefits of using the Web and describes the best practices for its use. This paper is divided into four sections. The first section reports our experiences with the use of the Web as an information resource for students writing technical reports. The second section presents our findings on the quality of these technical reports, focusing on the disadvantages that we attribute to the use of the Internet. In the third section we make recommendations for its use in higher education in technical fields and finally, our conclusions are presented in the last section.

Experiences in the Use of the World Wide Web in Engineering and Engineering Technology

The unquestionable advantages of using Internet resources in engineering and engineering technology cannot be denied. Students have access to a vast collection of documents relevant to their fields, from manuals and data sheets from manufacturers, to standards published by various regulatory agencies and so on. However, the use of the Web in higher education is not exempt from potential problems. Following the guidelines from the European Convergence Education System in Europe and ABET in the US, students in three sophomore-level courses of an Industrial Electronics Engineering program (with numbers ranging from 30 to 40 students) at the Polytechnic University of Valencia (Spain), were asked to write technical reports on specific areas of their curriculum. Engineering education in Spain has traditionally lacked a strong component in oral and written communication and in strategies for information search and retrieval. While in the US there has been a stronger push towards developing these skills, we have found that in general, students are still not proficient in oral and written communication and lack discrimination when dealing with the amount of information available in the Internet. In order to write the technical reports for this exercise, the students had to conduct research work to find the appropriate information. The technical reports were evaluated using a dual approach: an academic evaluation based on the contents and an evaluation of the information sources used by the students in writing the reports. Our main findings can be summarized as follows:

1) Almost all of the students employed the Web as their only source of information. Fewer than 5% used specialized journals and textbooks. Unfortunately, this is not a new finding, as many students rely on the Web as their only information source (Stenger & Goode, 2000).

2) In most cases, the outlines and contents of the reports were of very low quality.

The in-depth study of the students' work shows the following characteristics:

1) In the most flagrant cases, we could observe direct "cut-and-paste" from the material found online for 30% to 40% of the submitted reports. This is extremely easy to do with the current technology. In the reports that had a large content of "cut-and-paste" we could also observe that the students did not use any technical or scientific criteria to select the paragraphs that they copied. It seemed that their major concern was the inclusion of nice figures and pictures and that they used the first information site that they found.

2) Most of the information obtained via the Internet was not read by the students prior to its inclusion in the report. This was apparent from the many grammar and syntax expressions easily identified as Latin-American and very uncommon in Spain, where this exercise was conducted.

3) Some very basic definitions that are easily accessible from basic textbooks, were obtained from Internet sites of uncertain authorship.

4) The students frequently used information from the website of only a single manufacturer.

RESULTS AND PRELIMINARY ANALYSIS

It has never been so easy for students to access technical information in the form of data sheets, catalogs, etc., from manufacturers of electronic equipment and components as it is today with the widespread use of the Web. It was unthinkable just few years ago that students would be able to own and access all the data sheets available today (Lozano-Nieto, 1999). The existence of drawings and pictures available on the Web complements the almost constant flux of written information in textbooks. Also, Web resources allow for animations showing processes that otherwise are very difficult to describe in a textbook or in the classroom. Finally, short video clips can provide complementary information, thus enhancing the learning experience.

However, despite the attraction of using this graphical information, there is also the risk for education to become centered on anecdotal information, such as nice graphical displays, while avoiding the physical laws that govern the processes. Mathematical descriptions may be left behind in favor of the over-simplification of graphical representations. We have also found that engineering material found on the Web is often not rigorous, is of small pedagogical value to the students, is too specific, is sometimes sensational or purely false, and is generally non methodical (Levine, 2005). For instance, manufacturers are centered on their own products while ignoring those of their competitors for obvious reasons. Even references and links deemed "educational" on their websites are biased towards their own products, providing no information or acknowledgment of competitor's products. This is contrary to the academic method of research in which authors cite opposing points of view and will point out possible shortcomings in their own investigations. As a result, students are not able to learn about alternative approaches from other manufacturers or about the different industries that play a role in that specific market segment. This happens because students are not conscious that the manufacturer is using a subjective outline to present the information and also

because students tend to believe all the information provided by a prestigious manufacturing firm. Had the students previously consulted specialized textbooks, they would have been aware that the discourse used by the manufacturer was related to marketing criteria, and not to technical or scientific criteria. Johnson (1999) has reported that his students perceived commercial websites with a great deal of skepticism in contrast to their perception of government and academic sponsored sites.

We believe that the problems regarding the information contained on the Web have two different aspects: their technical content, and the way the information is laid out. As a consequence of the self-learning process that happens when students use the Web for an information search, there is a risk that they will adopt the explanatory models normally used on the Web. Therefore, the threat to their education comes not only from the use of deficient information but also from acquiring these specific explanatory models, to the detriment of old-established ones. In particular, after analyzing all the work from the students, we have found the following potential threats when using Internet resources in higher education:

1) *Immediateness*: there is always a fast answer for any question.

2) *Up-to-the-minute*: any recent information is more relevant than past information even to the detriment of solidly based truths.

3) *Attractive*: all the manifestations on the Web have to attract attention, such as using layout, colors, multimedia effects and so on.

4) *Multiplicity*: any topic can be observed from numerous points of view.

5) *Non linear approach*: The Web-based learning allows for students to change from one link to another even within an educational site. The Web is inherently a non-linear medium in which the user has the power to choose what comes next. Students can jump from link to link when they feel like doing so or when they get tired of viewing the current page. On the opposite side, traditional textbooks follow a linear approach, i.e. we cannot continue to the next chapter if we have not mastered the current chapter. Printed media requires longer attention spans than Web-media.

In our opinion, these aspects can lead to the following detrimental learning consequences:

1) Novelty becomes more important than stable knowledge.

2) The “assumed truth” is neglected when compare to superficial details. Therefore, in a system of sedimentary knowledge as formed by layers, this tends to devalue the foundations of this knowledge.

3) Esthetics has a value equivalent to, or sometimes higher, than the content.

4) Since there are numerous points of view to present or justify for any topic, it may seem that all of them can be equally true.

5) Finally, neither the contents nor the format are adapted to the character and the recipient of the message, contrary to what happens in the traditional classroom education in which the teachers adapt their exposure to the specific characteristics of the students.

Recommendations and Possible Solutions

Based on the ideas described in the previous section, we believe that the following considerations may be useful in the use of the Web in engineering and engineering technology.

First, we have observed that students have a lack of understanding of search strategies. In order to become successful professionals, they need to learn how to search effectively and how to analyze critically the information retrieved. It is clear that there is a need for them to learn how to search for and analyze information. The question becomes one of who should be responsible for this learning process. The best answer is provided by a multi-facet approach, in which students in technical and non technical courses search for and analyze information, guided by their instructors and reinforce this information with other support services, such as the library, learning centers, etc. In any case, we as instructors need to recognize two effects that we believe are prevalent in today's undergraduate education: the "Google effect", and "the spell checker effect". The first acknowledges that students tend to take any link from Google (or the currently fashionable search engine) at face value, believing that because it is on the Web and Google retrieved it, it is therefore reliable. The second recognizes an alarming trend that we have observed in which a spell checker in a word processor may accept or change a word that was spelled correctly, but is not what the student had in mind. With the failure on their part to contextualize a specific word within their written report, often aggravated by the fact that students do not re-read what they have written, the most basic element of critical analysis disappears.

Second, due to the information being available on the Web at all times, students feel that they can set their own schedules without being subject to the opening-times of the library or other facilities. While there is certainly a positive effect in being able to find and consult information at any time, this may also lead to procrastination on their part, as they believe there is time to complete their work in the future. This fact brings us to ask ourselves if time management skills should be part of the higher education curriculum, and if so, who should be responsible for developing these skills in our students.

Moreover, today's students are essentially different from the students of earlier generations and have learning skills totally opposite from the learning skills of instructors and teachers. The latter were educated following the so called "Sesame Street" culture in which a single subject was taken and repeated from many different points of view until they learned it. Drill exercises, for example, are based on this pedagogical approach. Today's students, however, have been brought up in the MTV culture, characterized by information given at a very fast pace and rapidly changing between different subjects, thus creating a very short attention span for these students.

This difference in learning styles creates a culture clash that needs to be bridged. We believe that instructors should play an important role not only in helping students use the most appropriate tools to search for information but also in helping them analyze the information that they have retrieved. This can be achieved by following the following points when assigning tasks that involve a search for information:

1) To develop guidelines within the writing assignment that will help students to understand the different types of information sources and when each type can be particularly useful. The Web contains a large amount of information but it is highly unstructured. Furthermore, there are no established criteria to assign a level of credibility to a source. Some authors have reported success in developing specific workshop sessions for students (Stenger & Goode, 2000).

2) To develop in-class activities that will help students to understand the different objectives, structure and approach used by various types of technical documents such as technical reports, scientific papers, manuals, data sheets, patents, etc. (Fentiman & Demel, 1995).

3) To incorporate in these exercises resources that address the specific characteristics of preparing and presenting technical documents (Haramundanis, 1998).

4) To stress the importance and utility of the classical materials used in higher education in engineering and engineering technology such as textbooks, specialized journals and trade magazines. At the same time, we should stress that the Internet cannot be considered a substitute for these materials but rather a supplementary resource. For example, when discussing a law of physics that has been mathematically or experimentally demonstrated and can be found in textbooks, the latter should be cited instead of Web pages. Petroski (2005) suggests that part of an assignment should be a compilation of bibliographic references based on more than just Internet resources.

5) To furnish the students with examples of poorly written work that will highlight deficiencies observed previously, such as material deliberately unfair or with few information sources. These examples, could be created by the instructor if necessary, can also be used as examples to develop criteria to critically analyze information.

6) To make students become an active part in creating information on the Web instead of being passive consumers. For example, students could be asked to write their technical reports as Web pages. The process of posting the information gives the students the opportunity to analyze how they present the information and how information is presented by others (Alexander & Tate, 1999). It is interesting to note that our experience shows that even in these cases students tend to be less rigorous in their assignments than for those assignments submitted traditionally (Dumont, 1996).

7) Write the assignments in such a way that the “cut-and-paste” process is avoided. This can be achieved by having students re-write material so they have to reflect on the information that is presented instead of merely searching for information.

In summary, it is crucial to help engineering and engineering technology students become proficient in the search for and analysis of information. These procedures, which are consistently taught early in other scientific programs such as physics, biology, psychology, etc., are lacking in today’s engineering programs. If we ask ourselves the reason for this difference in educational approach, the answer is probably based on having to balance a clear and scientific solution with a practical solution in most cases, although a full treatment of this topic is beyond the scope of this paper. Therefore, in order to help students to plan strategies before searching for information, we also need to provide them with the tools to assess how relevant a specific source may be (Stenger & Goode, 2000). We can achieve these goals by the following recommendations:

1) Do not assume that students and instructors have the same thinking patterns. Our experience in graduate school, our professional practice of engineering, and our teaching have all given us very distinct thinking patterns compared to undergraduate students.

2) Be very specific when developing writing assignments, ensuring that assignments are clear, not leaving any areas open to interpretation. We need to be very specific and detailed in order to avoid students having to guess what we want in a particular assignment.

3) Help students avoid becoming confused and lost by compartmentalizing long assignments into a series of well defined tasks with specific deadlines for their completion.

4) Use examples and mock assignments to show students what we want to accomplish in each task and how they should present the results.

We are aware that the points outlined are not easy to put into practice and achieving them may require a considerable time, especially given the fact that they should not be incorporated at once into any course, but should rather be viewed as a global strategy within an engineering program. We also need to emphasize the multidimensionality of Internet resources (Enright & Libert, 1999). Finally, we must emphasize that we are aware that the Web is not totally responsible for the problems described in this paper. These are rooted in causes whose analysis goes beyond the scope of this paper. Student habits such as not reviewing their own work for grammatical and syntactic errors are part of a common underlying problem in higher education that needs a more global approach for its solution.

Conclusions

We believe that the Internet has the potential to play an important and critical role in higher education. This potential is enhanced when instructors help students understand the problems and limitations of relying only on the Web in the search for information and when they inspire their students to extend their use of traditional information tools such as textbooks and specialized journals. The experiences presented in this paper fit within a broader research activity that should investigate the framework of today's higher education, determine what we should expect from our graduates and students, assess the validity of the educational process in today's society, that we as educators have learned, and the validity of all our educational assumptions.

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