Optimizing MERLOT for Optimal ICT Literacy in Engineering Education

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Abstract: - In order to be prepared for the workplace and lifelong self-development, today's students need to be able to access, evaluate, use, manage, and communicate information in many formats effectively and responsibility; they need to be information literate. While technology has become more prevalent, its effective use, particularly in academic and workplace settings, is vastly uneven. Formal instruction by knowledgeable instructors is required. However, those instructors themselves need to be ICT literate in order to select appropriate resources to expand physical and intellectual access to information. This paper discusses ICT literacy as it applies to engineering education, and suggests ways to incorporate ICT literacy into the curriculum, focusing on resources provided in MERLOT.

Key-words: - ICT literacy, MERLOT, OER, instructional design, information literacy, digital literacy

1 Introduction

In order to be prepared for the workplace and lifelong self-development, today's students need to be able to access, evaluate, use, manage, and communicate information in many formats effectively and responsibility; they need to be information literate.

While technology has become more prevalent, its effective use, particularly in academic and workplace settings, is vastly uneven. Formal instruction by knowledgeable instructors is required. However, those instructors themselves need to be ICT literate in order to select and incorporate resources to insure student ability to access and use digital resource to increase learning.

This paper discusses ICT literacy as it applies to engineering education, and suggests ways to incorporate ICT literacy into the curriculum, focusing on resources provided in MERLOT.

2 Background

This era is sometimes labelled the Information Society or the Knowledge Society, reflecting how information drives economies and societal action. As early as the 1991 SCANS (Secretary's Commission on Achieving Necessary Skills) report, governmental agencies have noted the need for employees who can: locate, interpret and organize information; communicate information; create documents; solve problems; work with a variety of technology; and know how to acquire new knowledge [1]. More currently, The Educational Testing Service (ETS) identified the most important workplace competencies; problem solving, collaboration communication, category flexibility all reflect ICT literacy [2].

The vast expansion and application of information is largely due to technological advances. At UNESCO's 2013 World Summit on the Information Society, governments and world leaders stated that sustainable development depends on education. To that end, ICT (information and communication technologies) facilitate access to, interaction with, and generation of knowledge. Within that framework, the participants noted:

> The rapid diffusion of mobile communication, establishment of Internet exchange points (IXPs), the increased availability of multilingual content and Internationalized Domain Names (IDNs), and the advent of new services and applications, including m-health, mobile transactions, e-Government, e-education, e-business and developmental services, which offer great potential for the development of the knowledge societies [3].

People now have greater access to ideas globally, and have a wider repertoire of tools to use and generate information. Intellectual capital has

replaced material capital, which means that today's learners must become competent in using and managing information and technology.

Most recently, the United Nations 2030 Agenda for Sustainable Development requires equitable access to more information, implemented through ICT literacy, in order to improve people's lives [4].

2.1 Definitions

Information literacy, as defined in 2015 by the Association of College and Research Libraries (ACRL), comprises "the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" [5]. This definition emphasizes dynamism, flexibility, individual growth, and community learning.

Information literacy facilitates a major facet of higher education: providing students the means to become critical lifelong learners. Indeed, as students develop and practice these skills, their learning increases across academic domains. Testing a hypothesis can transfer to justifying a thesis statement, for instance. This same overall purpose, then, requires the collaboration of faculty, library and administration.

Digital literacy refers to the ability to use technology effectively and responsibly. While historic technology literacy applied to tools operation and programming for advanced users, by the 1990s technology literacy focused on the use of applications to access and generate information. In the early 21st century, Europe used the term "information and communications technology" (ICT) to cover online engagement, applications use, and elearning [6]. The Partnership for 21st Century Learning uses the term ICT literacy to describe the ability to use technology effectively, including ethical and legal implications [7]. ETS defined ICT proficiency as:

> the ability to use digital technology, communication tools, and/or networks appropriately to solve information problems in order to function in an information society. This includes the ability to use technology as a tool to research, organize, evaluate, and communicate information and the possession of a fundamental understanding of the ethical/legal issues surrounding the access and use of information [8].

ICT literacy is herein defined as the ability to access, manage, integrate, evaluate, create, communicate information purposefully, knowledgeably, technically, and ethically.

A good guide for ICT literacy for teachers is offered by UNESCO [9]. It utilizes a grid to organize these competences noting depth by comprehension through creation: understanding ICT in education in terms of policy, curriculum and assessment, pedagogy (technology integration, complex problem-solving, self-management), ICT tools (basic, complex, pervasive), organization (classroom management, collaborative groups, learning organizations), and professional learning (personal digital literacy, managing ICT literacy, and modeling it). Even though technology integration is just one aspect of the guide, several other competencies are needed in order to demonstrate that competency.

2.2 Standards

ACRL updated and transformed their earlier information literacy standards in 2015 into a digital age framework that posits six "frames," which are those critical gateway or portal concepts through which students must pass in order to develop genuine expertise within a discipline, profession, or knowledge domain. The six threshold concepts that anchor the frames follow (with detailed explanations at http://www.ala.org/acrl/standards/ilframework):

1. Authority Is Constructed and Contextual
2. Information Creation as a Process
3. Information Has Value
4. Research as Inquiry
5. Scholarship as Conversation
6. Searching as Strategic Exploration

The Framework seeks to address the great potential for information literacy as a deeper, more integrated learning agenda, addressing academic and technical courses, undergraduate research, community-based learning, and co-curricular learning experiences of entering freshman through graduation [10].

On the global stage, the International Federation of Library Association and Institutions (IFLA) and UNESCO developed recommendations on information and media literacy. The committees focused on the importance of addressing knowledge and skills relative to both content and the format in which that content is communicated [11].

With CSU campuses seeking more diverse student populations, including international students, addressing the global aspects of information and media literacy not only helps students become more marketable in the global market but it also helps them become more culturally and globally

competent as they work with information from around the world.

The International Society for Technology in Education (ISTE) produce the most well-known set of technology literacy standards, including ones for teachers [12]. The latter include:

- Empowering student to learn and apply technology literacy standards
- Designing digital age learning experiences and assessments
- Using data to inform instruction and student support
- Modeling and promoting digital citizenship
- Engaging in collaboration, leadership and professional growth.

ABET provides the main standards for engineering education, all of which address ICT literacy [13].

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

In all cases, ICT literacy can improve student learning through redesigned syllabi, course content, and course delivery. Additionally, ICT literacy standards provide a framework for assessing student achievement.

3 Integrating ICT Literacy Resources into the Curriculum

At this point in time for higher education, a discipline-based approach to ICT literacy integration makes the most sense. Many universities include ICT literacy as a general education requirement, but even then the concepts and skills are usually taught within an academic subject context, such as engineering design processes.

To incorporate ICT literacy thus requires can academic teachers gain deeper understanding of information and technology themselves. Because the nature of information and technology has changed in recent years, these concepts might not have been addressed explicitly in academicians' preparation. Furthermore, many post-secondary faculty have not had formal training in instructional design. In that respect, both parties are at the "starting line" in terms of ICT literacy integration [14]. On the other hand, post-secondary institutions are providing faculty support through instructional designers. An ideal team for ICT literacy integration, therefore, consists of the discipline instructor, the academic librarian, and the instructional designer. With such a team, each can contribute his or her expertise, and cross-train teammates. Eventually, the academic instructor can carry the load of ICT literacy, with just-in-time specific support from the librarian and instructional designer [15].

3.1 MERLOT

Increasingly, faculty realize that the importance of digital resources, not only for textbooks but also other materials that can be accessed online. Particularly as instructors see the need for scaffolding and enriching learning, they need to find additional resources that can help their students learn. This task can seem daunting to faculty who have little extra time to hunt down and evaluate reputable sources. Furthermore, students need to have ICT skills in order to access, evaluate, engage with, and transform those digital resources.

To this end, in 1997 the California State University (CSU) system established a repository of online learning materials, all of which are peer- or reviewed by members of the community. This free resource is called MERLOT (Multimedia Educational Resources for Learning and Online Teaching), and now links to more than 70,000 items. An international community of faculty, staff, students, administrators, librarians and others in education use and share these Open Educational Resources (OER) for the improvement of technology-enhanced teaching and learning.

MERLOT includes several subject-specific academic communities, including engineering (https://www.merlot.org/merlot/Engineering.htm), as well as faculty support services. One of them, the

ICT Literacy Project, uses several strategies for integrating ICT literacy into the curriculum in a systematic way. The ICT Literacy portal (http://teachingcommons.cdl.edu/ictliteracy/) provides a central location to help faculty integrate ICT literacy into the curriculum. The home page defines ICT literacy, and links to the introductory online tutorial workshop. Other web pages in the portal focus on specific aspects of ICT literacy including professional development, faculty resources, and assessment. Membership, which is free to educators and students, enables one to contribute materials, create bookmark collections of OERs, develop learning activities and web pages, and network online. In each case, the resources are assigned a unique URL, which can be embedded into course websites. For instance, among the ICT literacy project sources is a bibliography of library guides, articles and learning activity idea starters for engineering education (https://www.merlot.org/merlot/downloadFile.htm?materialId=1085068).

3.2 Instructional Design

A solid ICT literacy foundation provides a broad academic base. Discipline-specific ICT literacy offers students the opportunity to gain and practice in-depth knowledge and skills within one academic field. What does it mean to think and act as an engineer?

Textbooks can serve as a good starting point or reference tool for students. However, to address the various academic needs of students, as well as to affirm the richness and depth of the knowledge, skills and dispositions in a course, engineering faculty probably want to complement and supplement textbooks with other resources in various formats [16]. MERLOT offers thousands of relevant learning objects to help students gain the knowledge needed to succeed.

The first step in integrating ICT literacy is to examine program and course student outcomes. Another consideration to help match the objective to appropriate resources, especially digital ones, is Bloom's cognitive taxonomy, when determine how technology tools fit into the kind of learning faculty want students to experience. The key is to match the teaching and learning objective with the right resource in the most effective medium, and provide the support needed so students can engage meaningfully with the materials. Here are some guiding questions:

1. What do I want to do/ accomplish? What is my objective?
2. What relevant, high-quality resources are available -- and accessible?
3. What do I -- and my students -- need to learn to use the resource? -- and is the learning curve feasible?
4. Should I incorporate that resource into the course?
5. How will I incorporate that resource?

Furthermore, these resources may be used in many ways:

- Instructional aid
- Introduction to concepts
- Discussion starters (e.g., case studies, articles, videos)
- Required or optional reading to deepen understanding)
- Activity (e.g., simulations, drill and practice, research, production)
- Assessment.

Once the resources are selected, they can be integrated logically into the instructional design.

Assessment is particularly important as ICT literacy lends itself not only to gaining information but also communicating and generating it. Today's students need to apply their knowledge: to be producers of information, not just consumers of information. Technology has expanded the possible methods of representing and communicating ideas. To that end, as students demonstrate competency through producing information products, they will need to use technological tools -- and learn how those tools work [17]. Some examples of ICT-enriched ways to demonstrate engineering competency follow:

- Annotated bibliographies from engineering literature reviews
- Reports from design projects
- Problem sets
- Mechanical drawings
- Lab reports
- Data analysis
- Research projects
- Design clinic projects.

3.3 Sample ICT-Integrated Engineering Learning Activities

The following learning activities align engineering with the ACRL information literacy framework and showcase technology literacy, thus meeting ICT literacy expectations.

Information creation as a process:

Flowchart a design process.

Design a design process to reach a decision, and then critique a peer's process in terms of implications and consequences that follow from their reasoning.

Interview professional engineers to ascertain the use of ICT.

Information has value:

Compare advertisements for two competing engineering products or services; consider quantitative information and emotional appeals.

Create a graphic organizer that shows future implications, and supporting evidence, of the 9/11/2001 World Trade Center towers collapses on the design, construction and operation of skyscrapers.

Research the costs related to an engineering Research and Development department – and their ROI (return on investment).

Acknowledge all contributors, funding sources, grants, etc. for a project.

Authority is constructed and contextual:

Find a breaking engineering news story. What statements or ideas in the story need to be clarified or questioned?

Locate and summarize legislation and regulations that impact engineering (building code, accessibility, intellectual property).

Analyze an environmental impact report from different perspectives (e.g., engineer, environmentalist, mayor, developer).

Searching as strategic exploration:

Locate articles on an engineering topic in two different database aggregators (e.g., IEEE Xplore, ACM Digital Library, Compendex), and compare processes and results.

Develop and implement an engineering topical search strategy in various information retrieval systems using different user interfaces and search engines, with different command languages, protocols, and search parameters.

Research as inquiry:

Take photographs of existing buildings, and suggest ways to make them more sustainable/"green."

Analyze how ADA-compliant a building is, and make suggestions for improvements.

Use simulations to test designs.

Scholarship as conversation:

Create a timeline of engineering advances.

Conduct a citation analysis of engineering design reports.

Critique an engineering case study (e.g., DARPA Center for Seismic Studies).

4 Conclusion

The bottom line is that ICT literacy provides a bridge between engineering education and workplace competency. However, building that bridge requires faculty ICT competency and effective integration of ICT literacy into their curriculum using a rich collection of high-quality digital resources. Such efforts can be more effective when faculty collaborate with librarians and instructional designers.

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