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Teaching Information Evaluation and Critical Thinking Skills in Physics Classes

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The physics curriculum at all educational levels can be enriched to include tools for strengthening students' information evaluation skills. The *Report of the Joint APS-AAPT Task Force on Graduate Education in Physics* calls for such training to be part of graduate programs, but training to acquire these lifetime skills can be incorporated in the curriculum even before graduate level.

Not long ago, researching a school paper was a process that involved only one step: visit the library. These days students might not ever walk into a library since they have an immense amount of information at their fingertips (literally). In the end this may turn out to be an even more daunting task than browsing books in the library stacks or going through reels of microfilms of newspapers. There is a lot available, but how do you select, evaluate, and use what you find to best address the research question or to achieve the goal or task at hand? How will the "Millennial" generation (born 1980s–2000s) learn these skills? Can these skills be taught, and if yes, when and how should they be taught?

Background

A quick scan of the library and information science literature will reveal a number of controversial positions on this issue and there are no clear answers. Since the mid-1990s, librarians have been using the checklist model approach (assess authority, accuracy, objectivity, currency, and coverage) to teach students how to evaluate websites. An alternative model to the checklist has been proposed recently, through the use of a contextual approach when evaluating websites,[1] which uses comparison and corroboration of information. The launch of the Educational Testing Service's "Information and Communication Technology Literacy Test,"[2] designed to assess students' proficiency in information and communication technology literacy in a higher-education environment, has only added more angles to the ongoing controversy. The response of educational institutions to this new testing initiative remains to be seen. As for where we are right now when it comes to educating students on how to best use and evaluate information sources, the authors decided to first find out what students think about this topic.

The Students' View

In summer 2005 the authors conducted informal discussions with 10 participants in the National Undergraduate Fellowship Program in Plasma Physics and Fusion Engineering, a program that provides students with an opportunity to conduct research in the disciplines that comprise the plasma sciences in general and fusion research in particular at the Princeton Plasma Physics Laboratory (PPPL). The discussions were to assess the level of training received in school (with an emphasis on physics or other science courses) in evaluating and selecting information sources. The group that was interviewed was made up of students enrolled at liberal arts colleges, research universities, and high schools. The students came from different educational backgrounds and had graduated from both public and private high schools, with some being home-schooled. While the discussions were not part

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of a formal scientific study, the feedback received from students has been extremely valuable. These are the experiences and thoughts of the group interviewed:

- Work done for the language arts and social science classes involved extensive library research. In the source selection process, students have been instructed to review and assess the authority and validity of the sources, especially when using resources located through web searches.
- Humanities and social sciences courses offered at the college level are the only ones that require extensive literature research. Most papers required an unreasonable number of sources to be used and cited. The emphasis on quantity of sources was always detrimental to the quality of the content and research conducted for the paper. College research papers become in essence a compilation of sources without any original contributions.
- For science courses, laboratory reports are seen as valuable assignments because they included strict requirements for the writing style. No requirement for additional literature research on the topic at hand was included for lab reports.
- By specializing in a given field, there is little opportunity to experiment or learn other skills than what is required to major in a specific area. If evaluation of information sources is not required or encouraged in a specific field of study, then it will not be learned or used.
- Given the growing number of multidisciplinary applications of physics, there are opportunities to develop assignments that require the use and evaluation of information sources to answer questions and research topics beyond physics. Physics students should be able to read and interpret the literature of other disciplines that use applications or concepts of physics.

In sumer 2006, a group of 29 students participating in the National Undergraduate Fellowship Program in Plasma Physics and Fusion Engineering at PPPL was surveyed to assess the level of formal training received in evaluating online information. The answers given by this group mirrored the views expressed by last year's smaller group very closely. Out of the 29 students, 21 had received training in library research methods either in high school or in college. However, the courses mentioned by students that included this training in their curriculum were the English, humanities, history, and political science courses. Fifteen students responded that they have received training in evaluation of Internet resources. Those who haven't been taught how to evaluate Internet resources mentioned that they use the reliability of the website's domain as the main criteria, indicating that they use exclusively sites from .edu or .gov domains, and sometimes they use their "gut feeling" or "common sense" when deciding if a source is reliable or not.

Moving into Action

In order to prepare future generations to efficiently function and perform in the workplace, teachers at all levels and in all areas need to work together and integrate into the curriculum assignments and projects that help students develop critical thinking skills, which make them question and even doubt the information that they intend to use in school work, especially when the source of information is the Internet. Physics and science and technology teachers in general have an even more difficult task in addressing this need because of the nature of the subjects being taught and the ever-present pressures of satisfying the curriculum requirements. While this may not be easily achieved for every single physics course, there are ways to integrate tools for developing information and communication literacy skills with the current teaching methods even for physics courses.

Contextual Methods for Teaching Physics and Contextual Information Literacy Training

The contextual approach to teaching physics (using real-life contexts and events) was explored in the late 1980s in various formats. The need for addressing social issues associated with science and technology has led to a number of revisions in the physics curriculum all over the world: The Netherlands, Canada, the United Kingdom, and Australia.[3] Using a contextual approach involves the use of a real-life context to explore and understand a particular topic or phenomenon. It is argued that by using real-life situations, students will find physics more relevant and in turn they will be more engaged and motivated in the classroom.

The contextual approach to teaching physics seems

to be extremely versatile in fostering the introduction of critical thinking and information evaluation skills. In recent years, reports from UCLA's Project LEArning Portfolio for Assessing Engineering Information for Engineers (LEAP) describe the use of assignments in the classroom where high school students were required to answer a physics problem (energy transformation) by using real-life experiences that they researched at the library. During the process, the students used contextual maps to organize concepts and to describe their relationships.[4]

Contextual approaches have also been used in teaching engineering courses at the university level. Because the engineering curriculum focuses on real-world applications, it has been relatively easy to include assignments that explore engineering concepts in a contextual perspective and to require students to research and analyze the information found critically. An enriched syllabus has been experimentally introduced to undergraduate-level students enrolled in a geotechnical engineering course at Memorial University of Newfoundland. In this case, two research assignments that required extensive library and Internet research, followed by commentaries on how and why the sources have been selected, have been integrated in the course, with the goal of fostering the development of technical information literacy and communication skills.[5]

Putting It All Together

What one can find in classrooms today may very well not reflect the ideal model of contextual teaching of physics as described by Wilkinson.[3] However, no matter what the pedagogical model used for teaching physics is, as long as it incorporates references to contexts and real-life applications, there is room in the classroom or in the lab to include some level of information literacy training. A significant number of electronic resources (free or subscription based) are available at school media centers or libraries, and school librarians have been eager to join the lab or the classroom. Through continuous dialogue and cooperation, teachers and librarians can develop and integrate information- and technical-proficiency-enhancing assignments in the physics curriculum.

The impetus for paying more attention to literacy and communication skills is growing, as can be seen from the *Report of the Joint APS-AAPT Task Force on Graduate Education in Physics*: "An examination of the current status of graduate education in physics with recommendations for improvement in the curricula." According to the report, released in October 2005 and updated in June 2006, "The ability to find and evaluate information is crucial in the decision-making process. In physics, knowing the literature is an increasingly complex undertaking, and has significant implications for efficient use of research funds, and can raise questions concerning professional ethics (see below). The TFGE recommends that departments require communication training and information literacy/fluency in their graduate programs."[6] A number of institutions of higher education are taking concrete steps to address this requirement and a number of such initiatives were highlighted at the AAPT Summer Meeting held in Syracuse, NY, July 22–26, 2006. Similar steps, however, need to be taken in physics education at all levels.

The Science Education Program at PPPL teamed up with the Princeton University Furth Plasma Physics Library in an effort to assist interested schools in integrating information literacy skills in the programs sponsored by the Science Education Program. It is the goal of the Science Education Program to start an extensive dialogue with physics teachers and to continue the dialogue with the high school and college students. By learning what efforts are currently made by physics teachers to contribute to the development of the students' information proficiency skills and what type of support is needed, the Science Education Program at PPPL is committed to working on developing stimulating projects and assignments to integrate into the physics curriculum that would enhance the teaching of critical thinking skills. For illustration purposes, an example of a solar energy assignment in its original format and a revised format is provided in an online appendix.[7] The parts of the revised assignment that integrate the cognitive processes of the Information and Communication Technology Literacy framework are also included (see Fig. 1). For those interested in participating in the dialogue or contributing assignments and materials that assess student proficiency in the use and evaluation of information, please contact the authors. With significant contributions from the physics teaching community, a publicly available online resource center could be created to store examples of physics assignments, proj-

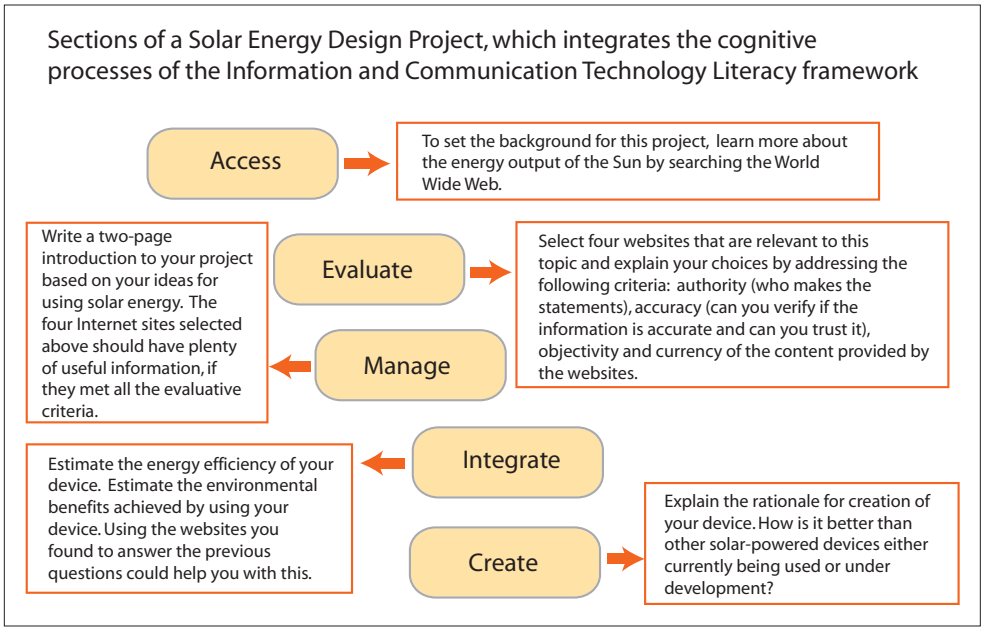

Fig. 1. Elements of ICT Literacy integrated in a physics assignment.

ects, or laboratories that incorporate information evaluation and critical thinking skills. Such a resource could be integrated within ComPADRE: Communities for Physics and Astronomy Digital Resources in Education, the existing project that has already brought together digital collections of high-quality educational materials in physics and astronomy (http://www.compadre.org).

References

1. Marc Meola, "Chucking the checklist: A contextual approach to teaching undergraduates website evaluation," *Portal-Lib. Acad.* **4**, 331 (2004).
2. ICT Literacy Assessment—Information and Communication Technology Literacy Overview (2005); available at http://www.ets.org/ictliteracy.
3. John W. Wilkinson, "The contextual approach to teaching physics," *J. Aus. Sci. Teach.* **45,** 43 (1999).
4. Zorana Ercegovac,"Bringing the library into the lab," *Sch. Lib. J.* **49**, 5 (February 2003).
5. Adriana Popescu and Radu Popescu, "Building research skills: Course-integrated training methods," *J. Prof. Issues Eng. Educ. Pract.* **129**, 40 (2003).
6. The full report is available online at http://www.aps.org/educ/grad/index.cfm.
7. See Appendix A at the FTP site http://ftp.aip.org/cgi-bin/epaps?ID=E-PHTEAH-45-014708. For more information, see the EPAPS homepage, http://www. aip.org/pubservs.

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