Bridging the Knowledge Gap between Secondary and Higher Education

Zorana Ercegovac

This article suggests several intersections for possible collaboration among different educational levels and disciplines. It describes some of the collaborative work between a physics teacher and a librarian at a high school level. In particular, science-integrated information literacy competencies have been selected that may easily be mapped to, and extended for, higher education. The paper concludes with directions for further study and a crossover between information literacy standards for secondary schools and colleges.

Learning transitions among different educational levels can present multiple challenges and often require a comprehensive juxtaposition of professional partnerships across varied disciplinary traditions. Obvious examples include transitions from the elementary school to the middle school, from middle school to the high school, and from there to colleges, universities, and workplaces. Yet, students are often a single summer apart from the giant steps they need to make in their lifelong learning journey. This paper discusses important ways that educators must work together to help the students make these transitions seamlessly and enjoyably.

This article first outlines those areas where educational connections offer a potential for fruitful partnerships among different types of librarians and between librarians and their faculty. Next, it describes some of the collaborative work between a physics teacher and a librarian at a high school level. The focus is on selected information literacy (IL) competencies that might be extended to higher education learning contexts. This work grew out of the author's own involvement in IL programs at very different educational levels starting with college students in general (since 1991), with engineering college students in particular (since 1995), and with 7–12 grade students and teachers (since 1998).[1–4] Finally, both sets of standards, *Information Power* and *Information Literacy Competency Standards for Higher Education*, are given side by side in appendix A.[5-6]

Educational Partnerships

This article discusses four levels of partnership that are important in helping students make transitions from one educational level to the next seamlessly and meaningfully. Collaborative information literacy (IL) efforts between librarians and

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Zorana Ercegovac is a Researcher in the Henry Samueli School of Engineering and Applied Sciences at the University of California, Los Angeles; e-mail: zercegov@ucla.edu. *This study is supported in part by the Engineering Information Foundation grant EiF01.17 and in part by the Computer Science Department of the Henry Samueli School of Engineering and Applied Sciences at the University of California, Los Angeles.*

faculty in K–12 schools and in colleges are relatively well represented in the reviewed literature. This activity is illustrated in cells C and A, respectively, of figure 1. However, less activity on partnerships has been seen among librarians from different educational levels (cell B). Reports on team efforts between secondary school teachers and their counterparts in higher education go under the headings of school–university partnership, in-service training, capacity building, and access to education (cell D).

Librarian–Faculty Partnerships

There is a rich body of literature about IL partnerships for college librarians and, separately, for school librarians. Each informs its predominant group of readers about examples of partnership in various

FIGURE 1
Spaces for Potential Collaborative Work Abound

	K–12 LIBRARIANS	**COLLEGE FACULTY**
COLLEGE LIBRARIANS	Type **B** Collaboration Early progress has been made. See, for example, the oint Task Force that was established in 1998 by AASL and ACRL: "Blueprint for Collaboration: AASL/ACRL Task Force on the Educational Role of Libraries" (http://www.ala.org/acrl/blueprint.html)	Type **A** Collaboration For an overview of this type of activity, readers are referred to, for example; "A Collaboration/Team Building Bibliography," by ACRL, covers case studies since 1984 focusing on the studies in 1990s (http://www.csusm.edu/acrl/il/collabbiblio.html).
K–12 FACULTY	Type **C** Collaboration Some progress has been made and reported mainly in school library literature. See, for example, the following resources: Reports are published by libraries, museums, and archives, such as Library of Congress American Memory lessons, http://memory.loc.gov/ammem/ndlpedu; the Smithsonian Institution, the National Archives and Records Administration; http://www.archives.gov/digital_classroom/; or the Exploratorium science program at http://www.exploratorium.org.	Type **D** Collaboration School–university partnerships are described in Dodge 1997; Lee 1999; NSF 1999; Oakes and Lipton 1999; The Texas A&M University (http://partnerships.tamu.edu/default.asp); University of California at Berkeley (http://k12.ucop.edu).

academic disciplines and interdisciplinary topics. Each reports challenges that librarians are facing with regard to powerful and evolving technologies, new software releases, accreditation standards, and user studies. College librarians learn about important efforts in team building from case studies that are typically published in *College & Research Libraries*, *Research Strategies*, *Reference Librarian*, *Reference Services Review*, *The Journal of Academic Librarianship*, and *Issues in Science & Technology Librarianship*, to mention just the most prevalent titles (cell A in figure 1). Many library schools offer graduate courses in bibliographic instruction; bibliographies on specific types of team building also are useful.[7,8] While writing this paper, the author came across the OCLC White Paper on the Web-based information patterns of U.S. college students.[9] The report suggests numerous areas that require attention, including access to sources, customer orientation in general, and instructional services, in particular.

Examples of K–12 grade IL partnerships are found in the equally rich literature that is typically reported in *School Library Media Research*, *School Library Journal*, *Knowledge Quest*, *Educational Leadership*, and *Teacher*, among other technology-related and discipline-related sources (cell C in figure 1). Anecdotal knowledge sheds light that college librarians try to keep current with their own readings, conferences, listservs, and, understandably, find little time to read school library literature. This author informally interviewed dozens of school librarians at state and regional conferences (e.g., California School Library Association) and found that school librarians, too, have little time to regularly read their own magazines and to attend workshops and conferences, let alone to read college and research library literature on IL issues.

Although some progress has been made where librarians have partnered with faculty to create integrated IL programs for their students, the potential for various educational intersections has just been recognized as an important component in the transfer of knowledge from one educational level to the next. In this direction, some collaboration between college and school librarians has only recently been witnessed (cell B in figure 1).

College Librarian–School Librarian Partnerships

A series of recent events has been representative of this type of interest. The Association of College and Research Libraries and the American Association of School Librarians created a Task Force on the Educational Role of Libraries.[10] The task force recommended four areas in which K–16 librarians could work together. These included various forms of collaboration, joint association activities, continuing education for librarians, and outreach projects among libraries, school districts, and colleges of education.

The March/April issue of *Knowledge Quest* has devoted its attention entirely to this topic: "One step beyond: From high school to college."[11,12] In addition, various agencies and professional organizations have expanded their efforts and funding in the K–16 programs (e.g., National Science Foundation [http://www.nsf.gov/], Association for Computing Machinery K–12 Task Force [http://www.acm.org/education/k12/], and its Special Interest Group on Computer Science Education [http://www.acm.org/sigcse]). This author spoke at several workshops and state annual conferences on "Survival skills: What every high school senior ought to know before entering college?" She also participated in the High School and Beyond Panel titled "Did they forget what they learned in high school?" at the 2002 Annual Meeting of the Association of Independent School Librarians, in Pasadena, California.

Although many collaborative opportunities exist, there are barriers that may hamper such partnerships. Gloria Leckie and Anne Fullerton, for example, describe tensions, or "pedagogical discourses," that exist between college librarians and their faculty.[13] Some of their findings include arguments on the part of faculty that there is no time for IL units to be integrated in already overcrowded disciplines; another seems to be faculty's lack of willingness to give up any intellectual space to library instruction. Leckie and Fullerton suggest a number of possible roles for instructional librarians in partnering with their faculty (e.g., as personal liaisons with departments, as collaborators, leaders, mentors, and supporters).

This author's personal experience has

Various curriculum standards competencies, analogous, often published different sources, teachers separately librarians.

been that teacher–librarian partnerships are likely to be more successful at the middle school rather than the high school level. Middle school teachers (grades 7–8) may be more relaxed in terms of scheduling their lesson units and more interested in collaborative projects than are the high school teachers (grades 9–12). It also may be easier to integrate IL units into social studies rather than into the sciences where activities in labs often overpower those in libraries.

School–University Partnerships

The collaboration among teachers at various educational levels is little published in library literature (cell D in figure 1). Reports are mainly targeted to teachers and found in journal titles such as *Teaching Education, Urban Education, Peabody Journal of Education, Education and Urban Society, Social Education,* and *Computers in the Social Studies*. Many reports are available through the ERIC document service. Collaborative efforts are directed toward supporting schools with evaluation tools, educational programs, and instructional technology; numerous outreach programs foster the college-going culture and concern themselves with educational equity and policy.[14–17]

More attention must be paid to actively participating in teaching classroom teachers and working with school and public librarians. Natural seed themes would be to help them integrate critical thinking into their lesson plans and to help design assessment instruments to measure students' IL skills before and after library interventions. This type of cross-training is useful if a more coherent teaching structure is to be created across the board.

The following section discusses some of the IL aspects that worked well with high school students and could be mapped to IL programs for college students.

Information Literacy Skills for Science Lessons

Some interest is just beginning to be seen in collaborative work between college librarians and school librarians, as illustrated in cell B in figure 1, between school librarians and teachers (cell C), and between school and college faculty (cell D). Various curriculum standards and related competencies, though analogous, are often reported and published in different sources, and read by teachers and separately by librarians. However, one is often reminded that students become information literate when teachers and librarians together guide the students through discipline-related projects. For that to happen, some unification also is needed in IL programs between and among school and academic librarians, as well as between school and college faculty.

This author has reviewed just a few core IL competencies that appear to be important for all students, especially in preparing them for science and engineering college majors. These are based on the two sets of standards in information literacy as well as science curricular standards for 9–12 grade levels.[18–21] Examples will be drawn from conceptual physics lesson units that are reported elsewhere.[22]

Helping the Students Getting Started with Conceptual Maps

Novices at any educational level are likely to be unfamiliar with the domain of their new topic or a given inquiry. Students often have a vague understanding of the concepts and terms they need to search under. To clarify search space as a whole, Ercegovac and Milling have had ninth-grade physics students use conceptual maps during their presearching phase.[23] Conceptual maps are used as learning and teaching tools that include phrases represented as nodes and placed in ovals or rectangles. The connecting lines between the nodes stand for relationships that exist between the nodes.[24]

A Case Study

Following is a typical sequence of learning events during the presearching phase. On the topic of energy transformation, students are presented with terms, including chemical energy, combustion, conservation of energy, decay, engine, expansion of gas, force, fossil fuels, fusion, gasoline, heat, kinetic energy, light, motion, nuclear, potential energy, rock layers, the Sun, and work. Before they walk into the physics lab, the students learn concepts and terms using previous knowledge of acceleration and force. They search both printed sources (textbooks, science and physics dictionaries, handbooks, encyclopedias) and online sources, including *Encyclopedia Britannica* on the Web (http://school.eb.com). Students are reminded that many of the basic searching techniques they learned in lessons on online library catalogs (Boolean operators, truncation, modification, and selection of search words) are applicable to searching in general. In small groups, students search terms in a variety of sources. As the terms become clearer, students are asked to create their own conceptual map on energy transformation. They cluster terms into major concepts: types of energy (kinetic, potential, chemical, nuclear, heat, light), carriers of energy (gasoline, light, motion of car, heated gas), places where energy is transformed (plants, the Sun, engine, rock layers), and transformation process (decay, photosynthesis, fusion, combustion, gas expansion). Major concepts are color coded, placed into the ovals, and connected with arches. Finally, students label arches that describe relationships among the ovals. The process is demanding, iterative, collaborative, and noisy. Students learn to use various skills from everyday experiences, the sciences, visual and spatial aesthetics, technology, and group dynamics.

While students learn about the assigned topic, they also learn how to plan and collaborate before they "go online." These skills are consistent with the *nformation Literacy Competency Standards for Higher Education* and the *nformation Power*. Specifically, students use a variety of reference sources to identify key concepts and terms that describe their assigned topic. By getting a feel for the territory, they are more competent to plan and control their search.

What Matters in Science Communication: From Secondary to Higher Education?

Basic IL units typically introduce library catalogs that give access to books, reference sources, atlases, and other similar publications. Students also hear a lot about various ways to search and evaluate Web sources. They become exposed to periodical literature that gives access to journals, magazines, newspapers, bulletins, and other serial publications. This is all helpful to the students in a variety of disciplines. In addition, students at all levels have heard about the importance of giving credit to ideas and authors that they include in their own reports and presentations and about the mechanics of doing so, that is, how to write bibliographies.

What they do not necessarily learn is about the culture of making science, of inventing, communicating personally and in published literature, protecting their ideas and inventions, being rewarded, and working in teams within social and political contexts. In this regard, the following resources are of special importance to the students. The three groups of sources briefly discussed here include information about patents and trademarks, primary sources, and factual data.

• *Patents and trademarks* offer an excellent basis for a variety of interdisciplinary projects. Students are introduced to the history of patents in the United States, the importance of patents and intellectual property, the differences between a patent and a trademark, and how to search each in the United States Patent and Trademark Office (http://www.uspto.gov). The office has developed a variety of educational outreach programs, including Museum, National Inventors Hall of Fame, and Project XL at http://www.uspto.gov/main/outreach.htm.

• *Primary sources* are discussed within the context of a general information life cycle, including some basic knowledge about funding agencies, proposing research to be carried out, and reporting results back to the funding agency. Examples of excellent contributions on Morse, Edison, or Bell, are selected from the American Memory Project (http://memory.loc.gov/ammem). Connections are made with local school archives and collections. Students are introduced to the concepts of appraisal, archival organization, preservation, and with digital collections at the National Archives and Records Administration (http://www.archives.gov) and the Smithsonian Archives (http://americanhistory.si.edu/archives/d-1.htm).

• *Factual sources* may be both science specific and of general application to science projects. An example of the former is the database on Material Safety Data Sheets (http://www.ilpi.com/msds), various databases by the Environmental Protection Agency (e.g., Toxic Release Inventory from http://www.epa.gov/tri, and the National Aeronautics and Space Administration from http://www.nasa.gov/kids.html). An example of the latter is the U.S. Census (http://www.census.gov/). MSDS are discussed in several projects. In an environmental course, students brainstorm "five W's": what is the waste, where is it created, when it is created, why is it created, and what can be changed. In this and other learning settings, students use rich census data that allow them to track populations, and plot them on online maps (mapping engine that uses 1998 TIGER/Line data® and 1990 Decennial Census data). Students use the EPA's Toxic Release Inventory database to track wastes in a given state or county on selected chemical emissions as these are released into the air, water, and soil.

Many of these information literacy experiences may be directly transferred to the *Information Literacy Competency Standards for Higher Education*. For example, work with conceptual mapping is directly related to Standard 1 (performance indicators 1.e and 4.a) and Standard 2 (indicator 2.b and 2.c). The awareness of patents, primary sources, and factual sources is related to Standard 1 (performance indicator 2) as well as to Standard 2. Finally, basic search techniques, elements of critical thinking, and bibliographical validity are applied throughout different sources and systems and provide a solid base to build on and to customize for different learning levels.

Bridges among administrative transitions students through.

In addition to the librarians' roles that Leckie and Fullerton suggested, Ercegovac and Milling's experience in making IL units work at a secondary school level are summarized in the following four models:

1. *Become a classroom teacher* yourself and weave through your lessons and projects as many IL experiences as you wish. This model may not be as easy to implement at a college level; exceptions are schools and programs for biomedical and chemical informatics where the nature of programmatic synergy demands a mix of expertise (e.g., http://www.informatics.indiana.edu).

2. *Teach the teachers* about specific ways they can empower their lessons with high IL content. This model may be enhanced if presented at conferences for teachers, archivists, museum curators, and administrators and not just at library conferences. At a college level, this model may be modi-

fied to research and teaching assistants, project leaders, visiting and new faculty. Some faculty members might want to be "briefed" on selected technological innovations; research panels might be used to bring together faculty and librarians to discuss issues of mutual interest.

3. *Prepare IL material and advertise in many different formats, media, and places.* The material may be printed out or published on the Web; materials may be advertised through the home department, personally, electronically, in newspapers, elevators, bookmarks, posters, and newsgroups. The material is likely to receive higher attention if it relates to proposed research projects or the existing research thrusts. Involve the faculty in this process, ask for their feedback, and revise the material accordingly.

4. *Speak the teacher's language*. This model is well practiced among college librarians, who themselves often hold advanced degrees in various disciplines. Examples are law librarians, medical and science librarians, and business school librarians.

Concluding Remarks

This article identified educational intersections between librarians and faculty as reported in the open literature. It briefly mentioned more traditional types of partnerships, those in which librarians have collaborated with their faculty. In particular, the article pointed to the two areas of potential partnership that have not been explored sufficiently. Working groups between school and academic librarians have just started to be seen. Each group can learn from another about IL programs, student characteristics and preferences, and different learning cultures. In addition, there is plenty of space for librarians to be included in school–university partnerships. This area ought to be further examined and developed.

Next, the article discussed some IL components for secondary schools that are standard based, inquiry driven, and resource rich. Each source is tied to students' everyday experiences, lab demonstrations, and high cognitive demands. Some of these elements may be transferred directly to college IL-integrated curricula. For comparison purposes, two sets of IL standards are given side by side in appendix A.

Bridges need to be built among administrative transitions that all students go through. The most fragile boundaries appear to be at the connecting lines, as students change their familiar schools, teachers, programs, and environments. These are between grades 6 and 7 (from elementary to middle school), between grades 8 and 9, and especially between the senior high school, and college freshmen. These educational areas are less studied, yet they offer promising partnerships among the existing capacities.

Notes

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APPENDIX A

Information Power (AASL & AECT, 1998) meets *Information Literacy Competency Standards for Higher Education* (ACRL, 2000)

AASL standards http://www.ala.org/aasl/ip_nine.html	**Performance indicators**	**ACRL standards http://www.ala.org/acrl/ilstandardlo.html**	**Performance indicators**
Standard 1 The student who is information literate **accesses** information effectively and efficiently.	**#1** Recognizes the need for information. **#2** Recognizes that accurate and comprehensive. information is the basis for decision making. **#3** Formulates questions based on information need **#4** Identifies a variety of potential sources of information. **#5** Develops and uses successful strategies for locating information.	**Standard 2** The student who is information literate **accesses** needed information effectively and efficiently. **Standard 1** The information-literate student determines the **nature and extent** of the *information needed.*	**#1.e.** [Student] identifies key concepts & terms that describe the information need. **#2** Student identifies a variety of types and formats of potential sources of information. **#3** Student considers the cost and benefits of acquiring info, defines a realistic *overall plan* and *time line* to acquire the needed information. **Standard 2 #2.b.** Identifies keywords, synonyms, and related terms … **2.d.** Student constructs … *search strategies* (eg., search vocabulary, Boolean operators…) **#4** Refines strategy, if necessary.

APPENDIX A

***Information Power* (AASL & AECT, 1998) meets *Information Literacy Competency Standards for Higher Education* (ACRL, 2000)**

AASL standards	Performance indicators	ACRL standards	Performance indicators
Standard 2 The student **evaluates** information *critically* and competently.	**#1** Determines *accuracy*, relevance, comprehensiveness. **#2** Distinguishes among fact, point of view, and opinion. **#3** Identifies inaccurate and misleading info. **#4** Selects information suitable to the problem/question.	**Standard 3** Student **evaluates** information and its sources critically and incorporates selected information into own knowledge, values.	**#1** Summarizes the main ideas. **#2** Recognizes biased information. **#3-7** Synthesizes, determines probable accuracy by evaluating sources, applies technology, reassesses the initial query and revises.
Standard 3 Student who is information literate **uses** information *accurately*, and creatively.	**#1** Organizes info for *practical applications.* **#2** Integrates new information into one's *own knowledge.* **#3** Applies info in critical thinking and *problem solving.* **#4** Produces and *communicates* info in appropriate format.	**Standard 4** Student *uses* information effectively to accomplish a specific purpose.	**Standard 2** **#5** Student extracts, records, and manages the information (eg., syntax of a citation for different resources).

APPENDIX A

Information Power (AASL & AECT, 1998) meets _Information Literacy Competency Standards for Higher Education_ (ACRL, 2000)

AASL standards	Performance indicators	ACRL standards	Performance indicators
Standard 8 (from the social responsibility standards) Student who is information literate practices ethical behavior in regard to information and info technology.	**#1** Respects the principle of intellectual freedom. **#2** Respects intellectual property rights **#3** Uses information technology responsibly.	**Standard 5** Student demonstrates many of the economic, legal, and social issues surrounding the use of info and accesses and uses information ethically and legally.	**#1** Student discusses issues related to censorship and freedom of speech. **#2** Participates in electronic discussions following accepted practices; uses approved passwords for access to info sources; complies with institutional policies.