ENVIRONMENTAL INFORMATION SCIENCE: A COURSE AT THE INTERSECTION OF POPPER'S WORLDS

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Today we encounter grand challenge science of global scale [*Basic Energy Sciences Workshop Report* (2009)]. Critical environmental challenges such as sustainable energy and climate change [*Climate Change 2007: Synthesis Report]* produce immense quantities of data and contribute to a data-intensive world. The need for coordinated information-management is rapidly increasing (Lynch, 2009).

Popper (1972) viewed the universe in three worlds: the physical world (which includes the environment), the mental world (subjective knowledge), and objective knowledge (products of the human mind). Brookes (1980) expanded this model by claiming the intersection of subjective and objective knowledge for the field of information science. We further expand the model by interpreting the intersection of all three Popperian worlds for the field of environmental information science. This project addresses the need for information skills required to thrive in our complex, data-intensive world by conceiving an undergraduate course in Environmental Information Science within the University of Tennessee's School of Information Sciences.

Introduction

The emergence of critical issues such as sustainable energy, climate change, and biodiversity, in addition to the exponential increase in environmental data, drive the need for environmental education with an information approach. Future environmental citizens and leaders need skills to identify, access, evaluate, interpret and use large volumes of scientific information. Charles Roth (1992) developed the concept of environmental literacy and identified four main components: affective, behavior, knowledge and skill. The knowledge and skill components specifically address information seeking and evaluation skills and are relevant to this study.

Thus, the authors asked the following research question: how could a special topics course in environmental information science bolster these skills and enhance the existing University's information science curriculum?

Research Methods

Relevant literature and academic course syllabi were reviewed to identify and define key elements of a course that would provide information skills necessary to fully participate in the

environmental decision-making process. Databases searched included the UTK library database, Google Scholar, Web of Science and Scirus. Preliminary successful search terms included "environmental education", "environmental literacy", "environmental information", and "environmental information literacy". Use of synonyms expanded searching to include related terms such as "ecology", "sustainability" and "informatics." These terms were used to construct more precise search statements. Additional search techniques employed field searching, Boolean operators and narrowing by subject area. Advanced searches in Web of Science retrieved between 25 and 45 hits per search. Related subject areas within the databases included "environmental studies", "information science and library science" and "education > scientific disciplines." Few relevant hits were found in the "information science and library science" category.

Since course syllabi are potentially advantageous to an institution, not all are publically available. The Association for Environmental Studies and Sciences (AESS) website was the primary source of syllabi reviewed for this study. The mission of AESS is to strengthen teaching, research and service in environmental studies and sciences and to improve communication across boundaries that divide the traditional academic disciplines. AESS has initiated a collaborative effort to identify and publish available environmental course syllabi for public use. The collection represents a wide range of environmental science, studies, and policy courses in U.S. and Canadian colleges and universities.

Other sources of syllabi included colleges and universities with known strong information science and environmental science programs. References to specific courses and programs indentified in the literature were also tracked down via the Internet. The preceding literature and syllabus reviews revealed an unmistakable gap in the research and curriculum addressing environmental information skills.

Research Findings

Available literature focused primarily on k-12 education and health informatics. Limited information was found for higher education. What was found focused primarily on environmental science as a domain discipline, as well as "adult education" outside of the college/university setting. The challenge of providing non-science students the skills they need to access, evaluate, interpret and use environmental information appears to have attracted relatively little attention. The search was expanded to international literature, and a wealth of information was available from European sources.

The literature review revealed key findings. One important theme supported a multidisciplinary approach to environmental literacy education. Educational requirements should encompass many

disciplines including the social sciences, natural sciences and humanities and not be limited to science (Orr, 1992, Coppola, 1999). This approach is consistent with the interdisciplinary nature of environmental issues. Furthermore, the literature specifically recommends against assuming environmental literacy depends on in-depth understanding of environmental science (St. Clair, 2003). The literature revealed other notable themes and concepts such as service learning, social learning, situated (or contextual) learning, participatory approaches, and data-intensive issues. Of these concepts, only one (data-intensive) reflects a concern for information-based competencies. Overall, few articles were situated within the information science subject area or demonstrated an information-based approach to environmental sciences and education.

The syllabus review determined that no courses were found that matched these objectives. Few courses broadly dealt with scientific or environmental information, and none appeared to give students the skills to identify, access, evaluate, interpret and use environmental information as part of the environmental decision-making process.

Course syllabi could generally be grouped into the following categories:

- Environmental science courses- focused on scientific (chemical, biological, ecological) processes and principles, generally occurred within a major or minor in environmental science
- Environmental policy courses- focused on the political science and sociological processes which produce environmental policy both in the US and internationally
- Environmental studies courses- focused variably on scientific and policy principles, and generally required less scientific background.

Numerous colleges and universities recognized the importance of environmental literacy by including environmental components in their graduation requirements (e.g. University of Georgia, University of Minnesota, University of North Iowa). Some schools addressed an environmental literacy requirement with a range of environmental-related courses to meet the requirement. Other schools built environmental topics into existing curriculum. The literature suggested limited success in these programs due to lack of focused learning objectives (Rowe, 2002; Moody et al, 2005; Krasny, 2009). Furthermore, the programs expressed little concern for information skills as evidenced from their course offerings.

Clear and consistent consensus exists on the need for improved environmental literacy; the disparity lies in the approach taken to achieve this result. This project recommends an information-based approach to environmental literacy.

Environmental Studies and Information Science

This project proposes an information-based approach to environmental education in academia, and thus a merging of two apparently complimentary disciplines: environmental studies and information sciences. Popper's pluralistic view of the universe offers a model by which to illustrate and define this merging. The authors conceived and added an information-based environmental course to this model.

Popper conceived the universe in "3 Worlds" (Popper 1972). World 1 represents the physical world. It encompasses physical bodies such as stones, plants, animals, and radiation. These bodies denote concrete objects. World 2 signifies the mental world. It includes thoughts, perceptions, observations, and subjective human knowledge. Products of the mind characterize World 3. Examples from this world include human creations such as books, poems, sculptures, symphonies, and scientific theories. World 3 objects are abstract entities that are embodied in World 1 physical objects.

Brookes (1980) argued that Information Science as a discipline is the overlap of World 2 (mental world) and World 3 (products of the mind). The core work of Information Science is to organize the objects of Worlds 2 and 3. If Information Science resides in these two worlds, it can be deduced that a course in Environmental Information Science would exist in the overlap of Worlds 1, 2 and 3 (figure 1). The study of environmental information incorporates physical objects from World 1, mental objects from World 2, and abstract objects from World 3. For example, physical objects may include resources from our natural environment; mental objects people's observations of the natural world; and abstract objects reports of scientific data.

As expanded and interpreted by the authors, Popper's pluralistic model supports the multidisciplinary nature of environmental studies and information science. The adapted framework illustrates the merging of these disciplines to fill an identified gap (see Research Findings). An information-based approach to environmental studies teaches information skills and competencies, including the abilities to identify, access, locate, evaluate and use information related to environmental issues and data. From the theoretical merging of the two disciplines, the authors began to define a course in Environmental Information Science. Key parallels between environmental studies and information sciences facilitated their pedagogy:

- Both are interdisciplinary in nature.
- Environmental data is complex and necessitates effective information skills.
- National science education standards and information competencies are comparable.

The authors considered these similarities and developed a matrix of core competencies for the course. These competencies were incorporated into a preliminary syllabus for Environmental Information.

Future Directions

Future directions will solicit the interdisciplinary community of environmental and information scientists to identify specific topics for an Environmental Information Science course. Pre- and post-testing of student skills and awareness will determine whether the course improves students' skills to identify, access, evaluate, interpret and use large volumes of scientific information. Course refinements will be made based on the experimental findings.

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