AC 2009-1391: ASSESSING INFORMATION LITERACY IN ENGINEERING: INTEGRATING A COLLEGE-WIDE PROGRAM WITH ABET-DRIVEN ASSESSMENT

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Assessing Information Literacy in Engineering: Integrating a College-wide program with ABET-driven assessment

As part of a college-wide effort, the Picker Engineering Program at Smith College developed a curriculum-integrated information literacy plan, and adopted information literacy criteria drawn from ACRL standards and faculty input. A review of the plan with an eye to assessment as well as a revision of our ABET outcomes criteria and assessment plan led us to a second round of information literacy criteria development. We sought to integrate the information literacy assessment plan with the overall ABET assessment plan for engineering. This process enabled us to streamline our criteria and facilitated the development of a realistic and rigorous assessment plan.

ABET outcomes criteria do not explicitly mention information literacy, but it is apparent that students cannot achieve many of the ABET outcomes without developing information literacy skills. Still, it is not common for these skills to be assessed as part of ABET outcomes assessment. Several mappings of information literacy criteria to ABET outcomes are available in previous work, connecting with several outcomes including lifelong learning, communication, and ethics. Because each institution develops their own set of outcomes, we did not simply adopt another's mapping but developed our own based on our understandings of our outcomes criteria.

This paper describes our process in developing our information literacy criteria integrated with ABET standards and our ABET assessment process. We also share the emergent assessment criteria, expected measures of achievement based in student work, and our assessment plan which utilizes electronic portfolios, reviewed by a team that includes librarians and others skilled in assessing information literacy.

Introduction and Background

Since the 1980s, there has been a growing recognition both of the importance of information competencies, and of the struggle students have in achieving them[1-3].The development of information literacy standards by the Association of College and Research Libraries (ACRL) -- and their endorsement by the American Association for Higher Education and the Council of Independent Colleges -- has spurred efforts to create curriculum-integrated approaches to information literacy[4]. As recognition of the importance of information literacy instruction in higher education continues to grow, and as regional accreditation bodies require assessment of information literacy, many campuses are developing plans for addressing information competencies of students[5].

At our small, private, liberal arts college, our formal information literacy program began in 2003/2004 with a focus on first year, writing intensive courses – the only set of courses the college requires all students to take. However, discussions and planning for a formal program began in 2002. Prior to that there was not a college-wide formal program, although the library conducted many instruction sessions that promoted and taught information literacy concepts. As the program developed, a curriculum-integrated approach was initiated, and individual departments were encouraged to write their own standards, using ACRL standards as a guideline. Departmental standards are sequenced and discipline-specific, with identified skills and resources students must learn as they move through their majors[6]. A primary portion of this effort involves librarians working with departments to develop and adopt information literacy standards. As of this writing 14 departments now have programs (nearly 40%), with 23 in discussion[7].

Phase two of this program is assessment. Already, some data are being collected and analyzed for the first-year program and within one department that was early in developing their standards. Anticipating the need to assess information literacy as the program progresses, the engineering program sought to consider how this assessment might dovetail with ongoing ABET-related assessments.

The Engineering program has experience with assessment for accreditation, having graduated its first class in 2004 and having sought and received accreditation retroactive to that class. Because of the need to create efficiencies where Engineering has already committed resources to ABET-driven assessment, we desired to integrate assessment efforts for information literacy with those of ABET.

The information literacy standards for Engineering, written initially without the experience of data collection for assessment, draw on both the ACRL information literacy standards for higher education (referred to below simply as ACRL) as well as the information literacy standards for science and technology (ILST[8]). Because the Engineering standards were written at the level of the performance indicators provided in the two sets of standards, they are therefore written at a highly detailed level[9]. However, ABET outcomes assessment occurs at a broader level, in which any number of detailed abilities may be brought as evidence of achievement of a single broader outcome. We agreed that the ABET outcomes were fairly analogous to the five ACRL standards (or ILST standards). We also agreed that the more detailed list of abilities included in our original information literacy plan (drawn mostly from the performance indicators listed in the ACRL and ILST standards) could be considered as potential measures of ACRL/ILST standard or ABET outcome fulfillment.

Thus, we sought to relate ABET outcomes with ACRL and ILST standards in order to facilitate the design of an assessment plan for information literacy. In reviewing the literature, we learned we were not the first to attempt such a map.[10,11] However, because ABET encourages each institution to create its own outcomes which encompass ABET criteria 3 a-k[12], it is necessary to map ACRL and ILST standards to our outcomes, not just to ABET's a-k.

Criteria and expected measures

Our program's ABET outcomes at the outset of our information literacy mapping process were as shown in Table 1, with mappings to ABET's a-k as indicated:

Table 1: Smith College and ABET Outcomes

Picker Engineering Program Outcome	ABET Criterion 3 Outcomes (a-k)
1. Conceptual Analysis: a conceptual understanding of engineering science fundamentals 2. Mathematical Analysis: the ability to quantitatively analyze a component, process, or system using theoretical and empirical mathematics, and engineering tools [a, e, k] 3. Experimentation: the ability to generate, evaluate, and understand data [k, b] 4. Teamwork: the ability to collaborate effectively with individuals with different skills and perspectives [d] 5. Communication: the ability to communicate effectively with a wide range of audiences using different modalities (visual, oral and written) [g] 6. Ethics: the ability to think critically and act reflectively in relation to engineering ethics and professional responsibility [f, h, j] 7. Life Long Learning: the ability to apply the fundamentals of how people learn to one's own education and life goals, and to use this knowledge to engage others in learning [i] 8. Problem Framing: the ability to define, scope, and frame an open-ended problem [c,e] 9. Design: the ability to apply knowledge of science, mathematics, and engineering to design a device, a system, a component or a process [a, c] 10. Context: the ability to practice engineering in context, responsive to the needs of people and the planet [h, j]	a. an ability to apply knowledge of mathematics, science, and engineering b. an ability to design and conduct experiments, as well as to analyze and interpret data c. an ability to design a system, component, or process to meet desired needs d. an ability to function on multi-disciplinary teams e. an ability to identify, formulate, and solve engineering problems f. an understanding of professional and ethical responsibility g. an ability to communicate effectively h. the broad education necessary to understand the impact of engineering solutions in a global and societal context i. a recognition of the need for, and an ability to engage in life-long learning j. a knowledge of contemporary issues k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

As we considered which of these outcomes related to the ACRL and ILST standards for information literacy, what struck us strongly was the sense that in both our program's outcomes and in ABET's phrasings of a-k, there is an assumption that the only data engineers work with are those generated through experimentation. The idea that engineers look up data in existing information resources is not captured by ABET's a-k.

Some other authors who have discussed the relationship of information literacy to ABET or other educational outcomes, including the ACRL, have placed information literacy primarily in the realm of lifelong learning[13,14]. We agree that information literacy has everything to do with lifelong learning, and it may be advantageous to cast information literacy as part of lifelong learning alone. One advantage is that it concretizes the notion of lifelong learning and makes it at least partly straightforward to assess for ABET. A second advantage is the simple fact that a one-to-one mapping lightens the load on assessors.

Even with these understandings, we felt it was important to map information literacy into other ABET outcomes. A curriculum-integrated approach ought to recognize the relationships lifelong learning has with other outcomes. We also felt it was important to alter one outcome (Smith outcome 3, mapping to ABET outcome b) to reflect the important fact that engineers are not ahistorical or cut off from their literature, but they routinely access, evaluate, use, and cite data that are generated by others.

We chose to map our program outcomes to both ACRL and ILST standards (Table 2). There is significant overlap between the two (the standards below represent our hybridization of the two), but we felt that each had elements not presented in the other that were worthwhile to include in our program.

Table 2: Mapping ABET Outcome Criteria and ACRL Information Literacy Standards

ABET Outcome (revision shown in *italics*)	**Performance Criteria (revision in *italics*)**	**ACRL/ILST Standard(s)**
3. Experimentation *and Data*: the ability to generate, *access*, evaluate, and understand data [ABET k, b]	the student is able to design and conduct experiments the student is able to analyze, and interpret data *the student is able to access and evaluate information*.	The information literate student determines the nature and extent of the information needed. [ACRL/ILST 1] The information literate student accesses needed information effectively and efficiently. [ACRL/ILST 2] The information literate student evaluates information and its sources critically and as a result, decides whether or not to modify the initial query and/or seek additional sources and whether to develop a new research process. [ACRL/ILST 3]
5. Communication: the ability to communicate effectively with a wide range of audiences using different modalities (visual, oral and written) [ABET g]	the student exhibits a clear writing style (readable, concise, cohesive) the student demonstrates an ability to effectively articulate an idea, argument or design the student is able to select and create an appropriate graphical representation for data	Either as an individual or as a member of a group, the information literate student uses information effectively, ethically, and legally to accomplish a specific purpose. [ACRL/ILST 4]
6. Ethics: the ability to think critically and act reflectively in relation to engineering ethics and professional responsibility [ABET f, h, j]	the student can critically analyze a case study in engineering ethics or professional responsibility the student can synthesize critical thinking and personal reflection in the process of decision making and other action related to engineering ethics and professional responsibility	The information literate student understands the economic, ethical, legal, and social issues surrounding the use of information and its technologies [ACRL 5 /ILST 4]
7.Life Long Learning: the ability to apply the fundamentals of how people learn to one's own education and life goals, and to use this knowledge to engage others in learning [ABET i]	the student demonstrates self-directed learning as a continual feedback spiral in which students are · self managing, (in which students articulate their own learning goals) · self monitoring,(in which students assess their achievement) · self modifying (in which students make midcourse corrections) students design a learning experience for others using knowledge of how people learn	The information literate student understands that information literacy is an ongoing process and an important component of lifelong learning and recognizes the need to keep current regarding new developments in her or his field. [ACRL 3 /ILST 5]

Assessment plan

Our assessment plan for student achievement of both our program outcomes and information literacy standards is still under development, but we will provide here a rough sketch of the process and measures we intend to use. In response to the need for more streamlined assessment methods we recently adopted an approach to overall program assessment using electronic portfolios, currently being pilot tested in several courses. We believe that portfolios may provide a more complete picture of overall student work than can be obtained from many traditional forms of assessment. The ePortfolio is an electronic collection of student work that demonstrates competencies and achievement over time. Students collect and align their work to program outcomes and performance criteria. Eportfolios engage students in reflecting and self-assessing how their work aligns with program outcomes. Students upload data that satisfy the performance criteria and/or ABET outcomes, with reflections that describe their progress. Portfolios are typically reviewed first within courses by the instructor, so that faculty feedback can be applied immediately to material covered in that particular course. On a programmatic level, student portfolios will be reviewed by a team of faculty and other experts after the sophomore year and again as students near graduation. A librarian or other information literacy expert will serve as part of this team in order to evaluate the information literacy aspects of student achievement.

Elements students might include in their portfolios as evidence of information literacy include the following:

- Certificate of completion of first-year information literacy quiz-tutorials (administered outside the department) which cover among other things, ethics of proper citation;
- Annotated bibliographies from a first-year course project on life-cycle assessment that reflect the ability to identify, access and evaluate a variety of resources;
- Homework assignment and test problem from a first-year course[15] directed toward students' abilities to access and evaluate information in the libraries and on the World Wide Web.
- Reports from a variety of design projects, laboratories, or research-based analyses in which students cite data in developing an argument. These types of assignments provide measures of the abilities to access and evaluate information, cite information ethically and in proper format, and utilize information to accomplish a particular purpose. As students progress through the curriculum, they are exposed to a greater variety and greater complexity of data, including data presented in tabular and graphical formats. In reports they also present data in a variety of ways through figures and tables.
- Design clinic projects in which students are called upon to access and evaluate data and/or collect new data, and report these data in a formal report to a real-world client with proper citations.

Portfolios are student-driven; students are given outcomes and performance criteria and it is their responsibility as intentional learners to develop evidence of their achievement of each outcome, and reflect upon its meaning for their education. In this way, the portfolio itself supports the development of life-long learning capacities.

In addition, at the end of every semester engineering faculty members evaluate program outcomes that were addressed in their individual courses. A brief summary is provided for each outcome which addresses whether or not there were modifications from previous semesters, what types of evidence were collected from students to support attainment, and how that evidence was analyzed. The percent of students who did not meet, met, or exceeded the performance criteria for each outcome is noted. Based on their analysis of data, faculty members offer recommendations for course and program modifications. These recommendations are later reviewed by the entire engineering faculty in conjunction with findings from the portfolio assessments.

Conclusions

A variety of maps exist linking information literacy standards with different sets of ABET outcomes. Here we have mapped ABET outcomes for our engineering program with ACRL and ILST standards. We have chosen to broaden this mapping outside of lifelong learning because we believe information literacy skills are developed across several technical and professional outcomes.

An assessment plan is being developed using electronic portfolios, with initial instructor feedback, at least one formative assessment of the portfolio after the sophomore year by a panel of internal and external faculty and librarians, and a summative assessment in the senior year by a similar panel.

We revised one of our ABET criteria (outcome 3, related to ABET criterion 3(b) on experimentation) in order to reflect importance of information literacy and the prominence of data derived from sources that are not original experiments conducted by a given engineer. It may be worthwhile for ABET to consider revising criterion 3(b) ("an ability to design and conduct experiments, as well as to analyze and interpret data") to accomplish the same objective and support information literacy as a critical component of professional preparation for engineers. An example of suggested new language for this outcome might be "an ability to access and evaluate information, as well as to design and conduct experiments to collect, analyze, and interpret original data."

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