Session 2586

Portfolios in a First-Year Design Course: Lessons Learned in the First Four Years

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Abstract

The first-year engineering design course at Union College has been offered in the Fall term for the last four years. The course has evolved significantly during that time, but the inclusion of a student portfolio has remained a constant part of the course. The paper presents ways that the portfolio goes beyond the traditional mechanism to assess the course and student learning. The portfolio is a mechanism to provide continuity in the engineering programs.

Students and faculty are encouraged to create their course portfolio in both hard copy and in Web Page formats. Three major benefits of the portfolio are described: 1) allowing students and faculty to review material from earlier courses, 2) allowing faculty to build on previous material that is archived in the portfolios, and 3) motivate students to appreciate the prerequisite course material that is preparation for upper-level courses and senior design projects.

Background

In the last six years, the Engineering and Computer Science Programs at Union College were extensively revised as part of a study funded by the General Electric Fund. One result is a first-year curriculum that includes a new common course, "The Fundamentals of Engineering and Computer Science." or First-Year Design course, for short. This course was offered for the fourth time in the Fall term of the 1999-2000 academic year. The catalog description of the course is provided in Appendix A; the course (ABET EC2000) objectives and performance measurements are detailed in Appendices B and C.

Union College offers undergraduate programs in Civil, Computer Systems, Electrical, and Mechanical Engineering. Material from each of these disciplines is incorporated in the first-year course. The course includes basic lecture material with extensive handouts, reading assignments [Oakes, 1999], engineering economic case studies, and studio exercises that cover design methodology and that prepare students for the culminating design project and competition.

Course Organization and Administration

The First-Year Design course is taken by all majors in engineering (civil, computer systems, electrical, mechanical, and undecided), and majors in computer science. The course schedule is a two-hour classroom meeting and a three-hour studio/laboratory meeting each week. These time periods are used for lecture, discussion, studio/laboratory time as appropriate for the course modules

Each offering of the First-Year Design course has involved a multidisciplinary team of faculty [acknowledged at the end of the paper] who administer, teach, assess, and modify it.

Each time that the course sequence has been offered, a number of changes have been made. This process of modifying the course is directed at improving the connections among topics and integrating the design project material [Lovas, 1996] into the whole course. Portfolios are consistently a component of the course and are required for each student. The general portfolio assignment is to include all of the course material (in hard copy or in machine readable form), in an organized notebook. The notebook may also include supplementary material. The objective of the portfolio is to document the work and effort that the student put into the course. The students also keep a design notebook they use to document their activities in the design project. This design notebook then becomes part of the course portfolio

Portfolios as an Assessment Tool

Since the portfolio contains student work from the beginning to the end of the First-Year Design course, it documents the improvements in the student's writing style, problem-solving ability, and written communication skills. These are well known and are valuable outcomes of the portfolio assignment [Panitz, 1993]. Each year, the faculty read and grade the portfolios. A two-step process is used. Initially, the portfolios are reviewed by the faculty during a laboratory/studio meeting. Feedback on the portfolio is given along with a reminder about the second portfolio review. Secondly, the portfolios are collected by the faculty at the end of the course and graded using a three element checklist for organization (table of contents is present), completeness (assignments and tests are present), and corrections (incorrect answers on exams or homework are corrected).

Sample portfolios from the First-Year course are collected and copied after the course ended and are used to document the course for our ABET review.

Portfolios as a Review Tool

One of the learning techniques in our curriculum is the “spiral approach” in which the students revisit topics and study them in greater depth. The approach can provide useful motivation for students but it is dependent on reviewing the material from the previous encounter. Portfolios provide an important mechanism for review before exams. In the First-Year Design course the digital counter was introduced and revisited. The first exposure was as part of a digital circuits laboratory, and the second exposure was as part of a design project to count the volume of pedestrian traffic on an existing campus foot bridge. The reuse of the digital counter in two parts of the course provides motivation for the students and a savings in time. The counter is also revisited in the logic design course where its operation is studied in greater detail. The student portfolio provides are a record of the past exposure to course material and accelerates the review process.

Portfolios as a Design Project Resource

The students learn and practice the steps in the design process. The portfolio then documents both the process and the outcome of the project. For example, one First-Year design project was to develop a weather station that collects data for a computer database and provides weather data for a Web page display. In the design of the weather station, the students incorporate temperature sensors and the digital counter studied in an earlier digital hardware module. Because the weather station consists of a modular set of sensors, it can be augmented or upgraded as the project is reused. In addition to the temperature sensor, commercial sensors for humidity, and rainfall were purchased. Students designed, fabricated, and calibrated a wind speed sensor.

Two years later, a team of students is working on a senior capstone design project that is concerned with the weather conditions and possible ice damage on the nearby Mohawk River. Some of the team members had worked on the original weather station and suggested that it be incorporated into the current project. Their portfolio documentation on the original project will be helpful in reviewing and planning this new use of the original project.

Portfolios as a Record of Achievement

One of the student projects in the First-Year Design Course was to design and build a wooden pedestrian bridge to improve a nature trail in a local city park [Wolfe, 1999]. The bridge was assembled on the Union campus and then transported to the trail site on a flat bed truck. Student portfolios and web pages record the project and the installation events. Thus, the documentation provides a record of the achievement during the course. For the longer term, the bridge design included its maintenance – cost and schedule. The portfolio is a reminder for regular maintenance, as a result the student design team will reform in the Spring of 2000 to apply another coat of wood preservative to the structure. Their portfolio provides a record of their achievement in the course and a schedule for follow up work.

Assessment of Portfolio Use

Student response has been favorable to the use of portfolios. However, some express concerns that they are not sure of what material to include or how to organize it.. Both faculty and students comment that general guidelines for portfolio contents and format are valuable and should be made clear at the outset. After assigning portfolios in the first-year course, several faculty have decided to use the portfolio requirement in other courses. In at least one case, a course has adopted an "open portfolio" exam policy as a reward for the student effort in compiling the portfolio.

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Appendix A: Catalog Description

Introduction to Engineering and Computer Science (Fall). A carefully-designed course that informs students about the various engineering and computer science programs at Union, including their historical and social context, and provides experience in technical oral, written, and graphical communication; an understanding of group dynamics and team work; time management, self-esteem, goal setting skills; an understanding of professional ethics using case study models; and development of a sensitivity to sexual harassment and cultural diversity in the profession. The course also provides a brief overview of the "engineering science" topics necessary for a professional engineering education (including solid and fluid mechanics, thermodynamics, heat transfer, material properties, electricity, and computer science) and introduces and illustrates the concepts of engineering design, team work, and problem solving through several small and one large creative individual and group design projects.

Appendix B: ABET Objectives

With respect to ABET Engineering Criteria 2000, Program Outcomes and Assessment, this course addresses the following outcomes:

- an ability to apply knowledge of mathematics, science and engineering;
- an ability to design a system, component or process to meet desired needs;
- an ability to function on multi-disciplinary teams;
- 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/societal context;

- a knowledge of contemporary issues;
- an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Appendix C: Performance Measurements

Student progress in achieving the desired objectives and outcomes for this course module are monitored and measured through use of some or all of the following:

- homework and in-class assignments designed to demonstrate mastery of basic concepts, the ability to conceptualize and synthesize a formal problem statement and algebraic mathematical model from a verbal description of a physical situation, and the ability to solve elementary engineering problems;
- participation and completion of an assigned team design project, requiring both a written report and an oral presentation, dealing with an open-ended problem that entails consideration of environmental impact, economic factors, and resource allocations;
- organization and submission of a portfolio containing a comprehensive representation of the student's work in the course.
- maintenance and submission of a laboratory notebook which contains the original data recorded during the laboratory sessions and documents the design process activities.

References

1. Ferguson, E.S. Engineering and the Mind's Eye, MIT Press, Cambridge, MA (1993).
2. Lovas, Charles M., Integrating Design into the Engineering Curriculum, Workshop Notes, Engineering Design Services, Dallas, TX (1996).
3. Oakes, William et al, Engineering Your Future, Great Lakes Press, Wildwood, MO (1999).
4. Panz, Beth, "The Student Portfolio: A Powerful Assessment Tool", ASEE Prism, March 1996
5. Wolf, Andrew and Christine LaPlante, "Bridge to the Future: the Freshman Capstone Design Project at Union College", ASEE Annual Conference Proceedings, Charlotte, NC, June 1999.

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