AC 2007-2649: USE OF AN ELECTRONIC PORTFOLIO FOR INDEPENDENT, ROBUST DIRECT MEASUREMENT OF STUDENT OUTCOMES

Kevin Sutterer, Rose-Hulman Institute of Technology

James Hanson, Rose-Hulman Institute of Technology

Robert Houghtalen, Rose-Hulman Institute of Technology

Use of an Electronic Portfolio for Independent, Robust Direct Measurement of Student Outcomes

Abstract

Assessment of student outcomes continues to evolve in the Department of Civil Engineering at Rose-Hulman Institute of Technology (RHIT). Direct assessment of outcomes is facilitated by the RosE Portfolio. The RosE Portfolio permits student submittals to an electronic system that sorts submittals by specified outcome, making the submittals available for later assessment by an independent team. The department uses an independent faculty and a practitioner for rating engineering submissions.

Use of the electronic portfolio is not without challenges. Student submittals must be made correctly to be fairly rated. The number of student submissions for rating must be adequate to assure reliable assessment of student performance, and the department must also identify successful and unsuccessful levels of student performance. However, used correctly and in conjunction with other indirect assessment, the electronic portfolio is a robust and flexible direct assessment of outcomes before graduation.

The paper summarizes

- the assessment process used for learning outcomes
- the RosE Portfolio submission process used by the department,
- the process of assuring sufficient submittals for rating,
- assessment of submittals, and
- interpretation of data.

Implementation of the electronic portfolio has not been without some resistance within the department. The paper presents both advantages and disadvantages of this assessment tool along with advice on how similar assessment may be incorporated into other programs. The presentation at the ASEE annual meeting will be in a "point-counterpoint" format by two of the co-authors.

Introduction

A program of learning assessment should be an organized process of (1) identifying objectives consistent with the program mission, (2) development of measurable learning outcomes, (3) setting performance criteria (rubrics) for each outcome, (4) collecting evidence of learning, and (5) evaluating the evidence. This process should be re-evaluated on a regular basis for necessary changes or adjustments. Development of an effective program for assessment of student outcomes can present a challenge to civil engineering programs. Ideally, assessment of learning would be continuous, directly documenting each student's activities and products during their baccalaureate work to assure achievement of all learning outcomes. This is, of course, impractical, so compromises are necessary for programs to assess learning. This paper provides a summary of the assessment program and facilitating tool in the Department of Civil Engineering at Rose-Hulman Institute of Technology.

Assessment of Student Outcomes

Assessment of learning can be either direct or indirect. Indirect assessment is often achieved without relative difficulty. For example, student surveys of their perception of whether they achieved a particular learning outcome are a form of indirect assessment. While helpful to a program's assessment effort, such assessment is not direct or unbiased. Another example of indirect assessment is for a group of faculty or an entire department to decide, based on their qualitative observations over time, whether a learning outcome was achieved by a group of students. Although still biased and not quantitative in form, this type of assessment can raise a program's confidence that learning outcomes are being achieved and is relatively practical to implement. Even so, an effective and practical assessment program should feature both direct and indirect assessment from multiple sources, and should highlight direct assessment whenever possible. With respect to many of the outcomes identified in the civil engineering body of knowledge[1], direct assessment of student learning is possible.

Although use of course grades is a direct assessment of learning within a particular subject, course grades are inappropriate for assessment of broader program outcomes and should not be part of a programs formal assessment program[4]. Thus, some other form of direct assessment is necessary when possible. That direct assessment should consider the students' best work, be independent of the learning itself, and be possible through an efficient, reliable process.

RHIT Civil Engineering Learning Outcomes Assessment

The assessment program for the RHIT Department of Civil Engineering is depicted in Figure 1. Note there is a three year assessment cycle with an embedded 1-year assessment cycle. The three-year cycle is to evaluate the assessment program and determine whether changes are necessary to keep learning consistent with the mission and objectives and to affirm the assessment scheme is working effectively. The one-year assessment cycle assesses student learning outcomes. This assessment includes faculty evaluation/course reflective statements (indirect), submissions to student portfolios (direct), and senior surveys/senior focus groups (indirect). Use of student portfolios as a means of direct assessment is well documented[5]. Direct assessment of learning outcomes, as evidenced in the student portfolios, is facilitated through the web-based RosE Porfolio tool. It should be noted that the key aspect of the direct assessment is the use of a portfolio system. The RosE Portfolio is simply a tool that facilitates that process.

RosE Portfolio

The RosE Portfolio at Rose-Hulman Institute of Technology has been in use for 6 years to facilitate direct assessment of student outcomes. The RosE Portfolio is a web-based system that allows students to electronically submit what they believe to be the best examples of their own work illustrating achievement of learning outcomes. In order to submit to the electronic portfolio, students access their portfolio using an internet browser. Students must log in to ensure the integrity of the data. Once logged in, students choose from the list of criteria that support the various outcomes. At this time we have 35 criteria that support 11 outcomes. Students upload the pertinent file, provide a descriptive title, and indicate where in the file the

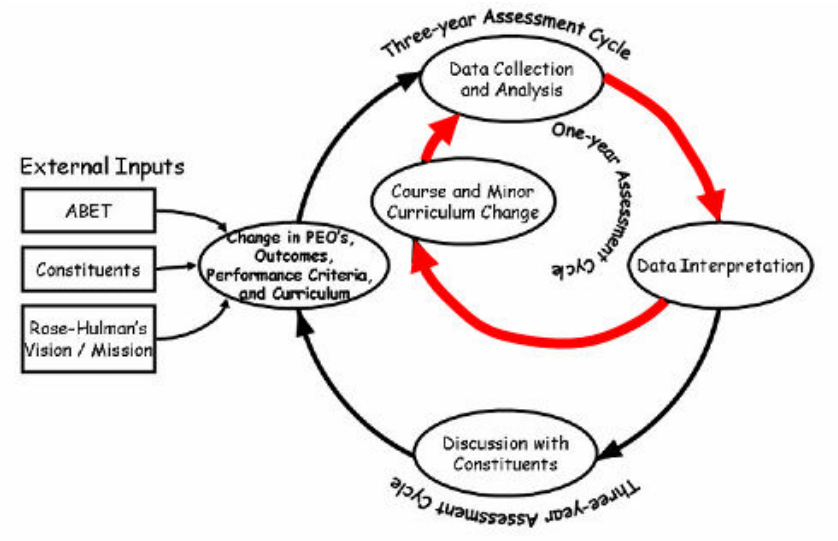

Figure 1. Outcomes assessment with emphasis on the one year assessment cycle.

reviewer can locate the evidence of achievement. As an added feature, students can indicate whether the file should be made available to potential employers. If the student had submitted to a particular criterion in the past, the new submission takes its place.

After work is submitted to their portfolios, teams of faculty and/or practitioners work together to rate student submittals. This typically takes place in the summer months or during breaks. To facilitate rating, a rubric is written for each criterion. This rubric is used year after year to assure consistency in comparing performance from one year to the next. The results of all of the rating of student outcomes within a department are prepared in a report to that department by RHIT's Office of Institutional Research, Planning, and Assessment (IRPA). In summary, the RosE Portfolio is a tool that simplifies collection, assessment, and interpretation of digital examples of student performance.

Student work is submitted to each criterion each year, but each of the department's learning outcomes is only rated at least every other year. Rating every other year has been found to be sufficient to monitor student progress while providing a good balance with the time commitment to complete rating. The rating results are summarized based on the percentage of students achieving a favorable rating. The goal is 90% achievement in each outcome. If the score is between 70% and 90%, the faculty members in the pertinent classes examine the learning outcome and make minor adjustments to the portfolio deliverable or to foundational learning. If the score is below 70%, the department must determine whether the low score is due to unacceptable learning or a problem with the assessment process.

An advantage to the process facilitated by the RosE Portfolio is the flexibility of the system to be adapted to changing assessment needs. For example, ASCE[1] is encouraging the addition of three outcomes to take the total number of ABET outcomes from 11 to 15. This is easily managed by the RosE Portfolio by increasing the number of submittals consistent with the additional outcomes. ASCE is also recommending minimum levels of achievement in each of the outcomes, with the levels currently based on Bloom's six levels of cognitive learning[2, 3]. The RosE Portfolio assessment methodology can incorporate levels of achievement by including

action verbs appropriate to the level of achievement into the rating rubrics and criterion statements. For both cases, the department need not change the assessment instrument, but only its components.

One Year Assessment Cycle

An example of the assessment of student portfolios within the one year cycle shown in Figure 1 is illustrated by submittals to the Problem Solving outcome:

Problem Solving: When given the opportunity, students will:

- Use appropriate resources to locate pertinent information.
- Compare results made by different methods of estimation to check for errors.
- Evaluate a proposed solution using appropriate criteria.

Data Collection. As described later herein, the department has identified assignments in courses that should provide good evidence of outcome achievement by the students. Students may submit any work they wish to their portfolio, but most submit the work identified by the department for each criterion. The targeted submittals for the Problem Solving outcome are created in the required junior year *Structural Mechanics I* class, which is held in the fall quarter. At the end of the academic year, one faculty and one practitioner assess the Problem Solving outcome. The faculty is a member of our department and the practitioner is typically a member of the department's Board of Advisors. The submittal for the second performance criteria (the "Compare results…" criteria shown above) is an assignment in which students perform structural analysis using both hand methods and computer methods. In that assignment, students compare results using the two methods and assess the reasonableness of the computer solution. This is an important skill in the era of computer-aided design, and fits the criteria well.

Data Analysis. The rubric for the "Compare results…" criteria is

> "student's comparison of results may be entirely based on estimation, calculation, or both. The student's work should make it clear they were checking their work by comparison with results obtained using a different method."

The web-based interface allows rating from any location so the practitioner need not be on campus to do their rating. The rating is made on the basis of the rating rubrics and uses a Yes/No benchmark for a single rating question: "Does this submission meet the criterion at a level expected of a student who will graduate from Rose-Hulman." When rating begins, the faculty member and practitioner use the rubric to rate three submittals. The raters must agree in their rating of the three shared documents. If they disagree on their rating, they resolve their differences prior to rating different student submissions. This inter-rater reliability test provides reasonable assurance that the two raters will be consistent on the remaining files that will be rated independently. As additional assurance, the portfolio system introduces a shared file every twelve documents in order to check that the raters have maintained their inter-rater reliability. Failure to rate the shared document identically will cause the system to stop the raters so that they can recalibrate their work before moving on to another document set, thus ensuring validation of the rating process. In addition to the work of rating, raters are asked to identify

exemplary documents among the files that they assess. This yields feedback to the appropriate faculty members and students.

Data Interpretation. As an example of data interpretation, the results for the Problem Solving outcome are given in Table 1. In addition to the direct measure of the problem solving outcome, and as noted previously, a number of indirect measures of this outcome are also examined. This occurs through the senior survey and the senior focus group. For example, a senior survey question requests that the seniors rate their ability to "formulate, analyze, model, and/or design civil engineering solutions." They are to use a scale of 5 (very well prepared) to 1 (very unprepared). Table 2 depicts the results of this problem solving question. All seniors take the survey and have the opportunity to elaborate on any question, both in writing on the survey and orally in the senior focus group held one week later.

Table 1: RosE Portfolio Results – Problem Solving

Problem Solving (Performance Criteria)	**2004 % Passing (Flag/Goal)**	**Action Plan (Responsible Party - JHH)**	**2006 % Passing (Flag/Goal)**	**Results/Action Plan (Responsible Party – JHH)**
Use appropriate resources to locate pertinent information.	41% (70/90)	Improve student commitment to the assessment process.	100% (70/90)	Great - Importance of learning outcome was stressed to students.
Compare results made by different methods to check for errors.	36% (70/90)	Ditto	95% (70/90)	Ditto
Evaluate a proposed solution using appropriate criteria.	0% (70/90)	Ditto	100% (70/90)	Ditto

Table 2: Senior Survey Results – Problem Solving Outcome

	2001 Score (Flag/Goal)	**2002 Score** (Flag/Goal)	**2003 Score** (Flag/Goal)	**2004 Score** (Flag/Goal)	**2005 Score** (Flag/Goal)	**2006 Score** (Flag/Goal)
Problem Solving: Rate your ability to: formulate, analyze, model, and/or design CE solutions.	4.1 (4.0/4.5)	4.6 (4.0/4.5)	4.3 (4.0/4.5)	4.4 (4.0/4.5)	4.5 (4.0/4.5)	4.4 (4.0/4.5)

Course and Minor Curriculum Changes. The data for the Problem Solving example in Table 1 indicated low achievements in the 2004 rating year. The rating indicated student success rates from 0% to 41%. In this case, review of the feedback from the raters and of the student submittal process indicated the majority of negative ratings on submittals occurred because students were not following the instructions provided for identifying appropriate materials to submit, not identifying the locations in which evidence of their work could be found in the submittals, and in some cases submitting materials to the criteria that did not demonstrate their learning in that outcome. In other words, negative ratings were being made because student submittals were made incorrectly. Confident that most students were achieving the outcome at

the level expected of graduating seniors, the faculty member resolved to better educate the students about the importance of the assessment process and enforced stricter expectations for following a correct submittal process. The rating results from the 2006 rating cycle show that although there was no significant change in the learning or workload for the class, the passing percentage for submittals increased dramatically.

Three Year Assessment Cycle

Every three years, in parallel with the regular one-year assessment activities, the department also

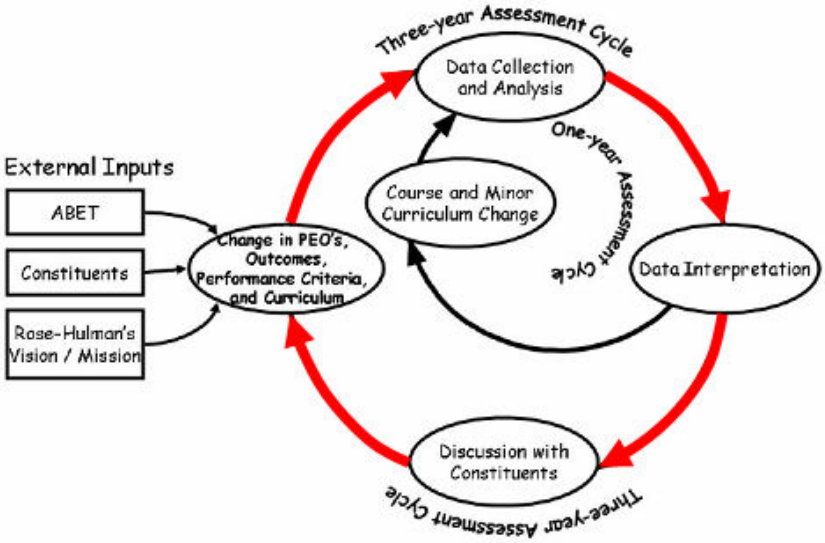

Figure 2. Outcomes assessment with emphasis on the three year assessment cycle.

examines the overall assessment program effectiveness (Figure 2). This discussion includes review of input from constituents (alumni, employers of alumni, and accrediting bodies), and determination of whether changes are necessary in program educational objectives (PEO's), outcomes, performance criteria, and the curriculum. Some examples of how this year cycle resulted in changes in assessment in the department outcomes assessment program follow.

Change in Data Collection. What the students submit to the electronic portfolio is crucial to the quality of data obtained about student achievement of the learning outcomes. Our original vision was for students to select the best example of achievement of the outcome from all their course work and submit it to the portfolio on their own initiative. However, many students have difficulty recognizing what really is their best work, or recognizing which student learning outcomes are best illustrated by their work. In addition, students are reluctant to take time to submit their work to their portfolio if it is not required for a class. After two years of poor submission rates, we decided to designate which course in the curriculum would provide the example of achievement. We picked assignments that used the skills associated with the learning outcome and had students submit the assignments as evidence of achievement of the outcome. Students can still submit other work that would supersede the designated submittals, but most student submittals are those designated by the department.

Change in Curriculum – Assignment Changes. Requiring targeted submittals to RosE Portfolio improved the submission rate to typically over 90%, but for many outcomes the success rate with respect to students' achieving the outcomes was still low (in some cases, below 10%). We

reviewed the process and discovered that, in many cases, existing assignments did not produce explicit evidence of achievement of the outcome. For example, one of our outcomes is "An ability to work effectively on teams". One of the criteria under that outcome is "share responsibilities and duties". If a team of students works together all term on a project, you can tell by the content of the report that the team must have shared responsibilities in order to accomplish the work. However, the report itself is not explicit evidence that the team members shared responsibilities and duties. Therefore, that submission of the report by the students would fail because the report itself was not direct evidence of sharing responsibilities and duties.

The faculty discussed two options to make the data better reflect student achievement of the outcomes: (1) change the rubrics to make them less prescriptive, (2) develop assignments that produce clear evidence that the outcome has been achieved. The department faculty decided that explicit evidence is important; therefore, we decided to develop new assignments. For example, as evidence that they share responsibilities and duties, students now create a planning matrix for their term project and assign team members to each project task. Students submit this new assignment to the portfolio. Note that one benefit of this new assignment is that the student teams now have a tool to guide them throughout the project. Therefore, the new assignments can have additional benefits for the students, and thus learning is improved. Developing an assignment that explicitly demonstrates the desired outcome has been an iterative process, and though it is formally part of our three year cycle, the department does not necessarily refrain from appropriate modifications in less than three years if strong evidence supports modifications. In fact, some of our assignments still do not produce sufficient evidence to satisfy our rubrics, though many of the outcomes now have reliable assessment data reflecting student achievement.

Change in Curriculum – Design of Experiments. Review of the department curriculum indicated that design of experiments is not formally included in the educational process, though the design of a data collection program is a part of the curriculum. Specifically, the design of a subsurface investigation is similar to one type of experiment design process. The junior-level *Soil Mechanics* course features a term-long design and implementation of a subsurface investigation, with special emphasis on use of geology, terrain, and the engineered geosystem to optimize the subsurface investigation. The department identified the work in this course as learning appropriate for design of experiments for civil engineering students. However, the subsurface investigation report prepared by the students at the end of the quarter did not provide direct, specific evidence that the students satisfied the criteria under Design of Experiments. The faculty member for the course thus developed a lesson and appropriate assignment based on the theory of design of experiments but modified to be appropriate to the design of a subsurface investigation. That lesson provided insights into design of subsurface investigations that was not previously evident to the faculty and facilitated an improvement in student learning.

+/Δ Evaluation

Over the 6 years since implementation of RosE Portfolio use by the department, we have noted both significant advantages and disadvantages to the system. We regularly consider alternative means of direct assessment as a part of our three year assessment cycle. The following is a summary of some of the advantages and disadvantages of the current assessment process facilitated by the RosE Portfolio system.

- It can be argued that developing assignments specifically to demonstrate what is expected in the rubric artificially elevates the success rate. However, it can also be argued that the data does not need to be obtained covertly to be valid; asking students to explicitly demonstrate the skills really might improve their skills.
- It can be argued that one assignment does not demonstrate that students have truly achieved the curriculum level learning outcome. This is true, but our assessment plan includes a map of the curriculum showing all the courses where the outcome is taught. For practical purposes, one assignment is simply sampling for quality control.
- The RosE Portfolio permits students to submit only digital evidence they have achieved the learning outcomes. This system is not created for direct observation of performance. Some important learning outcomes are difficult to demonstrate through the use of digital submittals, and other direct assessment methods may need to be considered by the department.
- Students are not directly observed to make their submittals. This leaves open the possibility that the work submitted may not be the student's own work.
- The open nature of the portfolio allows students to accidentally submit their assignment to the wrong criterion. Fortunately, instructors can review where students have submitted to the portfolio in order to identify such problems. But that does require time spent by the instructor.
- The process of developing assignments to explicitly show achievement of the outcomes helped the department identify areas where the curriculum lacked explicit instruction on certain outcomes. This revelation resulted in the addition of needed instruction in some areas.
- Assessment of the department's student submissions for the 35 criteria takes roughly 20 hours for each of two reviewers.
- Because of the open nature of the portfolio, students can overwrite the designated assignment with a submission that they feel is a better example. However, the students might not review the rubric to ensure that the new submission still explicitly demonstrates the required skills. Fortunately, students rarely do more work than what is requested of them.
- Accurate assessment data requires willing participation by faculty throughout the department. Even with willing participation, someone must be responsible to ensure that the instructors of the designated courses remember to make the assignments and have students submit to the portfolio.

Following are some additional positive and negative aspects of the actual RosE Portfolio system that are not necessarily a part of the assessment process, but affect the efficient use of the tool.

Positives

- Practitioner raters are important to the department. The web-based access to the RosE Portfolio makes it easier for both students and raters to use the tool efficiently.
- The RosE Portfolio system can be quickly updated when criteria or outcomes change.

Negatives

- File uploads can take time even on a fast internet connection, and review of digital files is not always easy compared to review of hard copy files.

- It is currently not possible to assign a single uploaded file to more than one criterion. Thus, submittal of a capstone design report for multiple criteria requires multiple uploads.

Conclusions

The RosE Portfolio permits efficient and paperless direct assessment of learning outcomes. The role of the RosE Portfolio in the department assessment program is as a tool that makes the process simpler. The system features advantages and disadvantages, has evolved since implementation as a department assessment tool, and is expected to continue to evolve. Other programs wishing to conduct similar direct assessment can do so through a similar electronic submission process, but the assessment can also be achieved, albeit less efficiently, with a hard copy filing system and data tabulation.

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