Continuous Program Improvement: A Project to Automate Record-keeping for Accreditation

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ABSTRACT

Preparing for an accreditation visit is generally viewed as a huge task. The new accreditation guidelines for Information Technology (IT) suggest that accreditation should not be viewed as a discrete event. With an emphasis on outcomes, assessment, and continuous improvement, the guidelines seek to encourage IT departments to look at accreditation as a continuous process; an iteration of data collection, analysis, and change. To that end, the IT Department at Clayton State University has developed a prototype system that maps the department's outcomes and course objectives to ABET-CAC's outcomes for IT. Student assignments are mapped to course objectives and program outcomes. Students submit their work for assessment via the web. Assessment metadata is extracted and used to revise individual courses and the program as a whole. To develop this system, students in database, ecommerce, programming, and quality assurance courses teamed with faculty to design and implement a prototype. The initial design was described in an earlier paper. Here, the development process and the prototype are described and a SQL script is provided so that other IT departments can create their own systems, benefiting from the work completed.

Categories and Subject Descriptors

K.3.3 [Computer and Information Science Education]: Accreditation, information science education, curriculum

General Terms

Human Factors

Keywords

IT Accreditation, Continuous Program Improvement, Database Design

1. PROBLEM STATEMENT AND GOAL

1.1 Background

The new accreditation standards for computing disciplines contain statements of intent with greater focus on outcomes, assessment and continuous improvement [6]. Assessments mapped to outcomes must be collected and measured against expectations. Analysis of this data should lead to planned curriculum revision. Curriculum development, in a very real sense, can be seen as a continuous process [2].

One approach to collecting assessments would be to use a course management system. Clayton State University (CSU) uses WebCT Vista. As with most course management systems, the software is proprietary and cannot be easily modified. Integrating data across multiple sections is difficult with no easy path to automating the task. Some faculty use WebCT for their courses, others do not. Like most technologists, the faculty have passionate opinions regarding the efficacy of WebCT: some love it, some hate it. This passion extends to course management tools in general. No consensus can be found. In summary, there are three problems with course management tools: 1) It can be difficult to aggregate data in order to judge continuous program improvement; 2) It can be difficult to get faculty to agree to use one particular product exclusively; and 3) Modifications to course management software will need to be made and such modifications may not be possible if the software is proprietary.

Booth [6] proposed a database template that could be used by many different information technology programs, irrespective of course delivery mechanisms. The database would document program outcomes and course objectives, mapping them to ABET's accreditation criteria for information technology [16]. Further, the database would capture assessment metadata from selected student work, providing a mechanism for evaluating the extent to which program outcomes are achieved. This data can be used to close the loop, demonstrating that assessment drives continuous program improvement [13]. Figure 1 shows the initial design.

Preston and Wilson [15] developed a simplified database that provided an initial prototype to test student submission of assignments via the web. WebSubmit has been successfully running for 6 years and has been adopted gradually and voluntarily by most faculty based upon its utility and ease of use. Students upload assignment files to the database and faculty review and assess student work electronically. While each faculty member may manage their course differently, using websites of their own design or WebCT Vista, selected assignments are chosen to be submitted via WebSubmit.

1.2 Problem and Goal

Preparing for an accreditation visit is generally viewed as a huge task [11]. With continuous program improvement as a guiding principle, accreditation should be viewed as a continuous process; an iteration of data collection, analysis, and change.

With the goal of developing a system for continuous program improvement, the problem addressed was that of merging WebSubmit with a database to map student assignments to the department's outcomes and course objectives and to map those back to ABET-CAC's outcomes for IT.

A second goal for this project was to involve students in the design and implementation of the system. Students in database, ecommerce, programming and quality assurance courses teamed with faculty to refine the design and implement a prototype. Projects of consequence provide a superior experience for students as they prepare for the world of work. Students need to develop the integration of skill sets that practical problems provide. Students see the value of project management and teamwork when performance deadlines have impacts beyond the classroom. In this case, students became users of the system they helped to create. As noted by Marchant and Marchant [12], projects such as this generate excitement and energy among students.

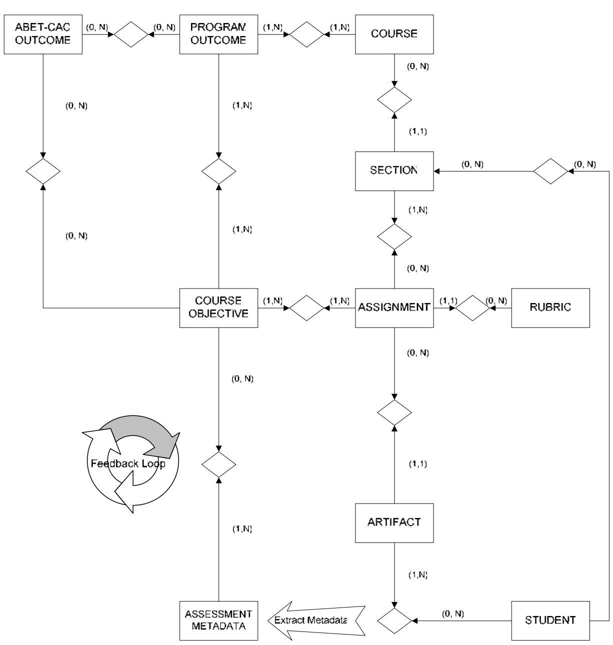

Figure 1. Database for Continuous Program Improvement

2. ARCHITECTURE AND DESIGN

Database students were asked to reverse engineer the WebSubmit database and then integrate the design elements of the database template proposed by Booth. Students discovered that several data elements were known by different names. They created a data dictionary to standardize data elements and document the work for programming teams. In addition, the relationships between entities ASSIGNMENT, RUBRIC, and COURSE OBJECTIVE were clarified. Students suggested that an ASSESSMENT entity and an ELEMENT entity be added and that the RUBRIC entity become a relationship between ELEMENT and COURSE OBJECTIVE. Figure 2 shows the revised design.

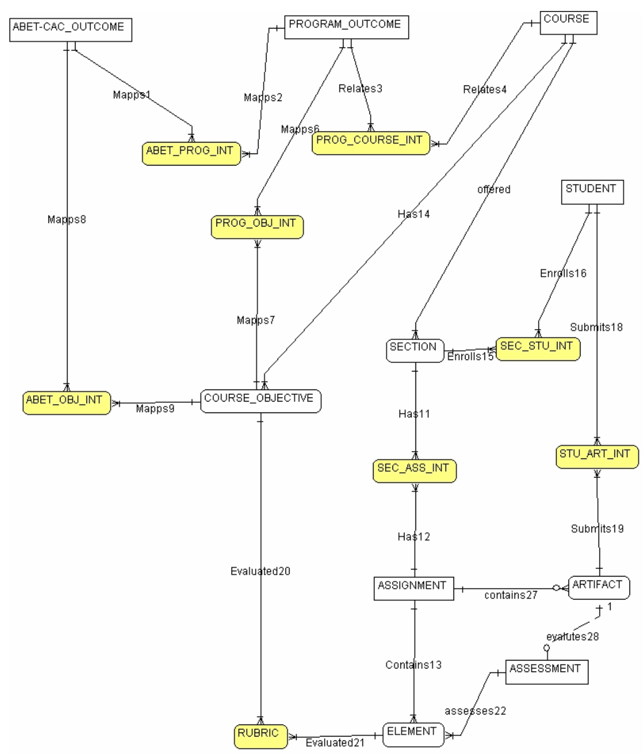

Figure 2. Revisions to Database Design

Since an ASSIGNMENT may assess several course objectives, it seemed prudent to allow ASSIGNMENT entities to consist of one or more ELEMENTS. Each ELEMENT may address one or more COURSE OBJECTIVEs. A COURSE OBJECTIVE may map to one or more ELEMENTs. The associated RUBRIC must have assessment standards for each objective-element pair. The ASSESSMENT entity extracts assignment ELEMENTS and corresponding grading rubrics to create a grading template and permanent record for each graded ASSIGNMENT.

The IT Department at Clayton State used Bloom's taxonomy of the cognitive domain [5] to develop a scheme for mapping program outcomes to courses. Three levels of mastery have been defined based on Bloom: developing level of mastery, mature level of mastery, and proficient level of mastery. Correspondingly, assessment rubrics for each assignment element rely on these three levels of mastery. See Table 1.

Table 1. Levels of Mastery

Level	Definition
Developing	Demonstrates an emerging level of knowledge and skills; can perform beginning skills and shows potential to perform independently.
Mature	Demonstrates a refined level of comprehension; is able to apply appropriate skills and perform both independently and as a team member
Proficient	Demonstrates a superior level of knowledge and understanding; integrates and applies skills across multiple areas both independently and as a team member.

When a faculty member creates an assignment, each element is designed to measure one or more course objectives. A given course objective might be assessed by more than one element. Course objectives support specific program outcomes and should be measured against a specific mastery level. For each objective-element pair, a corresponding rubric is recorded. Table 2 illustrates this hierarchy.

Table 2. Mapping Assignment Elements to Course Objectives

Program Outcome **Course Objective**	**Assignment** **Assignment element**	**Level of Mastery** **Rubric**
Program Outcome 1	Assignment 1	Level M
Objective 1a	Element a	Rubric 1a-a
Objective 1b	Element b	Rubric 1b-b
Objective 1c	Element b	Rubric 1c-b
Program Outcome 2		Level D
Objective 2a	Element c	Rubric 2a-c
Objective 2b	Element d	Rubric 2b-d
Objective 2b	Element e	Rubric 2b-e

3. BUILDING THE PROTOTYPE

The existing WebSubmit system has successfully managed over 200 course sections, tracked over 1700 students, and managed over 1700 assignments. This system has also collected over 23000 grades/assessments, but the idea of mapping outcomes and objectives to student submissions and using the assessment of these submissions for continuous improvement is new.

The assignment building tool (Figure 3) allows faculty to define assignments for each course. Each assignment has a name, description, and due date. Also, an active date field determines when the assignment becomes "visible" to students. Since objectives have previously been defined for the course, faculty can select the objectives that this new assignment pertains to.

After defining these elements of the assignment, the instructor can build the rubric for the assignment to define how it will be assessed. Each rubric item has a question (what is being looked for) and maps to a specific objective that was previously select for this assignment. Additionally, each rubric item is assigned a value to define its relative importance to the other rubric items; these values are used to calculate the overall points for the assignment. The system is flexible in this regard and does not require values to sum to 100; so an instructor could use their favored scoring method (which may or may not be 100-point based).

As a result, the instructor can define assignments with start and due dates for the students that map to specific course objectives. Defining the rubric when the assignment is created is advantageous to students in that the students know exactly what will be assessed and can then focus their efforts on meeting the expectations of the assignment. Defining the rubric when the assignment is created is also advantageous for the instructor because it allows the instructor to explicitly determine which course objectives are being assessed.

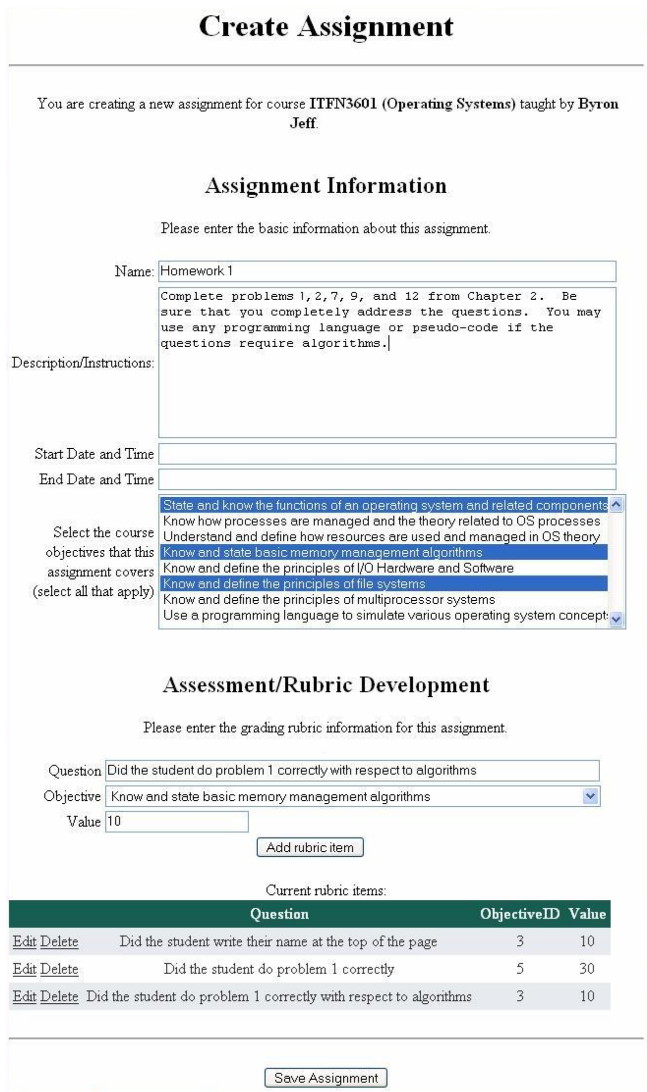

Figure 3. Screen Shot: Creating an Assignment

After the assignment has been defined and students submit their work, the instructor may assess/grade the submissions. Figure 4 shows an instructor's view in grading the submission of a student for a particular assignment. Here, all files that the student submitted are shown (with hyperlinks to download and view the files); note that the system also shows when the files were submitted.

The instructor can provide general comments to the student and give as much detail or as little detail as desired for feedback. Additionally, the rubric items previously defined for this assignment are displayed so that the instructor can assess which items the student successfully completed. By simply marking which rubric items were successfully met by the student, the score for the assignment is automatically calculated. Information regarding which course objectives the student has achieved is also stored (since rubric items are mapped to course objectives) for later reporting and for use in continuous improvement.

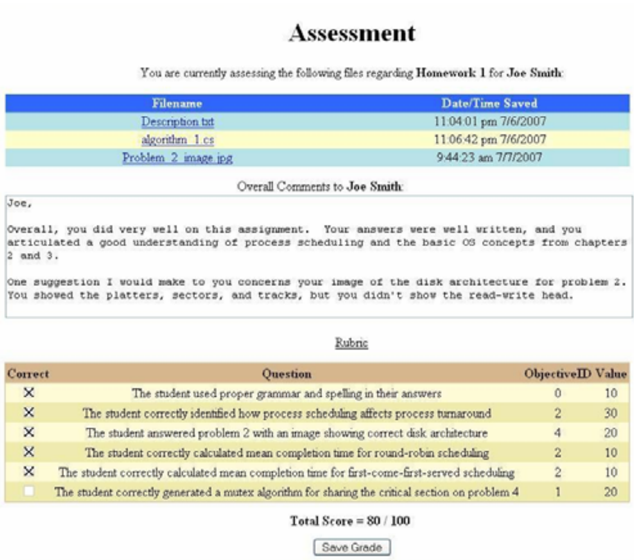

Figure 4. Screen Shot: Assessing Student Work

4. CONCLUSIONS AND FUTURE WORK

Involving students in the development of real working systems is rewarding to both faculty and students. Students begin to understand that systems and processes are vastly more complex than might be imagined by simple classroom exercises. Faculty benefit by having a ready pool of meaningful assignments, projects, and internship opportunities for students. In this case, both groups benefit by producing a system that will be used by generations of students and faculty.

The new and improved WebSubmit prototype is generic enough that it could be adopted by academic departments irrespective of specific course management tools that might also be used. It allows IT departments in particular to map their own program outcomes and course objectives to ABET-CACs outcomes for information technology. The system is flexible enough to allow individual professors to define their own point scales for grading while collecting metadata that can be used to judge the effectiveness of both courses and assignments. Further, because the system tracks version changes for outcomes, objectives, courses, and assignments, it documents continuous program improvement over time.

Construction of this prototype provides a working system that users can exercise and evaluate. SQL scripts to create the supporting database will be freely distributed to academic departments. Hopefully, several departments of information technology will implement the system and improve on it. Follow-up studies might develop evaluation instruments, perhaps based on models of continuous process improvement [1, 4, 7, 9] and ease of use [3, 8, 10, 14]. The developed instruments would survey users to determine the degree to which the goals of the design have been met.

Will this prototype application ease the burden of preparing for accreditation? Will outcomes-based accreditation standards emphasizing continuous program improvement result in better and more diverse information technology programs? The ability to capture data in similar formats across various programs should assist any future study designed to answer such questions.

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