Partitioned Recording of Test and Homework Scores as a Practical Means of Preserving Useful Data for Assessment

Marion O. Hagler
Mississippi State University, Department of Electrical and Computer Engineering, Box 9571
Mississippi State, MS 39762 hagler@ece.msstate.edu

Abstract - Recording only the total scores for work by each student destroys potentially useful and detailed information about students’ relative performance on different problem types and subjects. With contemporary software, it has become practical to record and collect scores on homework, tests and laboratory exercises to any level of desired detail and, from this recorded data, to compute, with only modest effort, measures of student performance for each topic listed on the course syllabus or according to measurable outcomes for educational objectives of the course. Because a teacher constructs the assessment workbooks in real time during the course, the workbook provides real-time feedback about student performance that the teacher can use to adapt the program of study during the term. This paper describes assessment spreadsheet workbooks developed for three different electrical and computer engineering courses at Mississippi State University.

Index Terms – Outcomes assessment, spreadsheets, education, information technology

INTRODUCTION

Although teachers ordinarily score separately each item on exams and homework assignments, the score they record for each student often is merely the sum of the student scores on the individual items that make up the exam or assignment. This process destroys potentially useful and detailed information about the students’ relative performance on different problem types and subjects, but it was practically essential before electronic means of storing and manipulating large amounts of data became widely available to teachers. With contemporary information technology, however, it has become practical to record student scores to any level of desired detail and, from this recorded data, to compute, with only modest effort, countless measures of student performance.

One possible approach to recording finely partitioned data on student performance relies on network-supported environments, such as Blackboard or WebCT [1, 2]. With the built-in functionality of these environments, simple assessments of students performance are easily implemented, particularly assessments of performance on learning activities provided within that particular environment. While the built-in functionality is convenient, extending the capability for assessment is not simple, partly because tinkering with a centralized software system can easily break it. One approach to overcoming this difficulty is to create a course in Blackboard, say, and then transfer it into TrueOutcomes, an example of web-based assessment software that offers broader capability for assessment and accommodates learning activities performed external to the environment more easily [3], [4]. An obvious requirement of the network supported software approach to recording finely partitioned student performance data is a strong institutional commitment that extends far beyond the individual teacher.

A second possible approach to recording finely partitioned data on student performance relies primarily on desktop or laptop computers [5]. Although these computers are usually connected to a network, most of the recording and manipulation of data in this approach uses widely available office software that runs on a local machine. Employing office software involves considerably more handcrafting than relying on WebCT, Blackboard, and TrueOutcomes, but the office software provides a powerful and flexible environment for extending and customizing assessment functions and for easily encompassing learning environments based on disparate, but authentic, software.

From experience during the past three years in electrical and computer engineering courses at Mississippi State University, this paper illustrates practical means of using Microsoft Excel workbooks to assess class average student performance according to topics specified in class syllabi and according to measurable outcomes related to learning objectives for the courses [6]-[8]. Although Mississippi State University offers excellent support both for BlackBoard and for WebCT, the choice of Microsoft Office software stems from its greater power and extensibility for assessment purposes. This approach complements the online assessment software available in the Department of Electrical and Computer Engineering at Mississippi State University by computing selected summary data for entry online at the end of each course [9].

Because a teacher constructs the assessment workbook in real time during the course, the workbook provides real-time feedback to the teacher about student performance. As a consequence, the teacher can adapt the program of study...
during the term in the light of detailed statistical characterizations of student performance.

**DATA SHEETS**

At the beginning of a term, construction of an assessment workbook begins by constructing a different data spreadsheet to collect each type of performance score (homework, exam, laboratory) that results from the course. The initial spreadsheet for exams, for example, will be copied and edited to form spreadsheets for recording scores on each subsequent exam.

Figure 1 shows a portion of a data sheet, identified as H1 on the tab near the bottom of the screen, for the first homework assignment. The first columns of the data sheets include the class roll, usually imported electronically. The columns beginning with column J and extending to the right correspond to different parts of the assignment. If a single problem has parts (a) and (b), separate columns can be allocated for each part to increase the number of partitions.

**FIGURE 1**

A PORTION OF A DATA SHEET, H1, FOR THE FIRST HOMEWORK ASSIGNMENT IN THE COURSE ECE 3153

Cells in rows 1 through 7 of column J use functions built into Excel to calculate various statistical quantities about performance of the class on problem 1 of this assignment. The formulas for these cells are copied into corresponding cells in as many columns to the right of column J as needed to record each part of the assignment. Because sheet H1 will be a template for sheets that correspond to subsequent homework assignments, it is convenient to copy the statistical cells into as many columns as might be needed for future homework assignments. To keep these cells from displaying anything (such as error messages) above unused columns, Excel IF functions in the formulas for the cells cause nothing to appear in the cells if no student data appears below them in that column.

During grading, scores for each student on each part of the assignment are entered into the appropriate cells. Recording the score for each part of the homework assignment rather than simply recording the total score for the assignment preserves much more detailed information about student performance for analysis on other sheets.

Column G in sheet H1 presents summary information about performance on the first homework assignment. The cell in column G beside the name of each student automatically sums the scores that have been entered into each column for this student. Rows 1 through 7 of column G identify the homework assignment and give simple statistics for the data that appears in the lower rows of this column.

Rows 9 through 13 of column G use nested IF statements to categorize student performance on the first homework assignment by letter grade: above 89.5 corresponds to a letter grade of A, above 79.5 and less than 89.5 corresponds to a letter grade of B, and so on.

Data sheets for subsequent homework assignments are made by right clicking on the H1 tab to make a copy of this sheet and then by renaming the resulting new sheet and editing the column labels to correspond to the parts of the new homework assignment. This approach, of course, reproduces not only the class roll, but also the relatively complicated formulas that calculate rudimentary statistics for each homework assignment.

Similar data sheets for each examination administered during the course can be constructed from the H1 data sheet. The columns of each exam data sheet correspond to each part and subpart of the examination. Data sheets for any laboratory exercises that constitute a part of each course are developed in much the same way.

**METADATA SHEETS**

The main objective in constructing the data sheets is to preserve detailed information that inevitably occurs during the grading process, but which traditionally is discarded to reduce the data set to a manageable size. The purpose of the metadata sheets is to begin the process of compiling the data in ways that give insight into student performance from various perspectives.

**Syllabus Topic Sheets**

As a first example of a metadata sheet, consider the sheet of Fig. 2, a sheet that compiles student performance on homework and examinations related to nodal analysis during a first course on circuit analysis for electrical and computer engineers. The rows below row 8 in this sheet contain copies of each exam item (part or subpart) and homework item and the corresponding average class score for that item. The scores are linked (Copy/Paste Special/Paste Link in Excel) to the corresponding homework or exam data sheet. The links, therefore, are active in that any changes of grade on the data sheets automatically update the entries on the metadata sheet.

On this sheet, all of the exam items are listed first, followed by the homework items. The copies of the exam and homework problems in the nodal metadata sheet are copied from the Microsoft Word files in which the homework assignments and examinations were prepared and then pasted (paste special/Microsoft Word Document object) into the spreadsheet as Microsoft Word Document objects. Many of the homework problems were copied, edited, and pasted from solution files...
that accompany many textbooks for undergraduate engineers. Thus, preparing the metadata sheets requires little typing.

Rows 1 though 7 of the nodal metadata sheet use functions built into Excel to compile the number of exam and homework items included on this metadata sheet and to display the average performance of the class for these items. Careful use of the Insert/Rows command in Excel permits the addition of exam items without manually adjusting the cell ranges in the Excel formulas used to compile the statistics in rows 1 through 7. This compilation of statistics will be integrated into a summary evaluation sheet for the course.

The metadata sheets for other topics in the class syllabus, which appear as tabs in Figure 2, are made in Excel by right clicking on the nodal tab to make a copy of this sheet and then editing it. This approach reproduces the layout and the formulas that calculate rudimentary statistics for each syllabus topic so that relatively little typing is necessary.

### Measurable Outcome Sheets

As a second example of a metadata sheet, consider the sheet of Figure 3, a sheet that compiles average class performance on a particular Measurable Outcome for the course, a part of the continuing assessment process for ABET accreditation [4].

In metadata sheet MO1, rows 10 through 22 list the weekly homework projects and the Final Project for ECE 1002, An Introduction to Electrical and Computer Engineering, a course for first year students. Column F tabulates scores on part 1 of any project that relates to this particular Measurable Outcome and columns further to the right (all except column G out of the range of the figure) correspond to additional parts of each project. Part 1 for none of the homework projects was related to MO1, so column F is blank, although column G and other columns further to the right in the figure contain scores. These scores are links to the scores that have been entered on the data sheets for the corresponding homework project. Thus, any changes in homework grades are automatically reflected on metadata sheet MO1. Column C of rows 10 through 22 sums the number of items that relate to MO1 for each project listed. Column B contains averages of the percentage scores for the items that relate to Measurable Outcome 1 from each project.

Rows 25 and higher in MO1 record average scores (linked from the data sheets for each test) on each test question that relates to Measurable Outcome 1 in Column C. Again, the test questions are pasted from the Word files in which the tests were prepared.

Rows 4 though 7 compile statistics for the class average performance data given in rows 10 and higher. This compilation will be integrated into a summary evaluation sheet for the course.

### Grade Sheets

As a third example of a metadata sheet, consider the sheet of Figure 4, a sheet that compiles grades for individual students,
as well as some grade statistics for the class as whole. The main purpose of this sheet is to compile information from the data sheets in a format that permits assignment of letter grades to each student enrolled in the course. During the semester, this sheet can be saved by Excel as an html file and displayed on the course web site after columns A through E have been deleted and the remaining data is sorted according to student-supplied random ID numbers. This approach permits students to remain anonymous and yet compare their performance with others in the class. At the end of the term, columns added to the grade sheet can be used for automatically calculating appropriate averages and assigning letter grades to each student.

**EVALUATION SHEETS AND DISCUSSION**

The evaluation sheets shown in Figure 5 and Figure 6 assemble metadata in a format that allows evaluation of class performance in the course. Figure 5 shows the class performance from the perspective of Measurable Outcomes. At a glance, the evaluation sheet shows to which Measurable Outcomes the course relates, how many homework (project) items and test items relate to each Measurable Outcome, and the class average performance on the items related to each Measurable Outcome. Because this sheet is linked to the data and hence automatically updates during the semester, a teacher not only can gauge class performance during the semester, but can also adjust test and project content to help attain relevant Measurable Objectives for the course.

![FIGURE 5](image)

**A PORTION OF AN EVALUATION SHEET CONSTRUCTED FROM THE PERSPECTIVE OF THE MEASURABLE OUTCOMES FOR THE COURSE ECE 1002**

Figure 6 shows class performance from the perspective of the course syllabus. Again, the evaluation sheet is automatically updated during the semester, so a teacher can gauge class performance on each topic and can adjust the schedule in response to the performance on each topic by the class.

![FIGURE 6](image)

**A PORTION OF AN EVALUATION SHEET CONSTRUCTED FROM THE PERSPECTIVE OF THE COURSE SYLLABUS FOR THE COURSE ECE 3144**

Although the evaluation sheets may summarize thousands of individual scores in several different ways, the effort required to prepare them is sufficiently modest that they can summarize the data in real time during the term. Besides the power of modern spreadsheets, the keys are careful design of appropriate of data and metadata sheets, reuse of these sheets by copying, and links to cells to reduce typing and permit automatic updating.

**ACKNOWLEDGMENT**

The author gratefully acknowledges support for this work as the Robert D. Guyton Chair for teaching excellence at Mississippi State University.

**REFERENCES**

[6] https://www.ece.msstate.edu/classes/ece1002/
[7] https://www.ece.msstate.edu/~hagler/ece3144/