Using Exam Cover Sheets to Tally Course Assessment Data

Julia L. Morse

Kansas State University, K-State at Salina

Abstract

One of the challenges of assessment is the extra compilation work required to collect and tally results of an entire class only on certain aspects of student work, specific to key learning outcomes. Entire exam grades generally represent a combination of outcomes and so do not provide good assessment information on specific outcomes. However, sorting out statistics on student performance data on only specific exam questions or aspects can be tedious and time-consuming. By applying itemized grading sheets as an integral part of the exam-grading process, student scores are already sorted by questions and therefore can easily be compiled by applicable learning outcomes. Application of spreadsheet tools or other programming automates the tallying process. This paper provides practical examples of grading cover sheets on regular exams to sort and tally student performance of various learning outcomes.

Introduction

In the process of enacting structured assessment of our engineering and technology programs, we have been challenged to compile and summarize student performance of the individual learning outcomes of the program. K-State at Salina's Engineering Technology programs have elected to assess student performance in large part by considering the exams, lab work, homework, projects, presentations, and other class assignments already being evaluated as part of the student's graded course work.*

While it is true that this information is already being collected and evaluated, usually student work combines several learning outcomes; the overall score provides little information toward assessment. For example, an exam may have only one or two questions that capture student "ability to practice professional ethics and social responsibility," or this outcome may be embedded within a design problem. In such cases, the overall exam or assignment scores do not represent student performance of the one particular outcome in question. Unless the exam was automated through a scan form system or submitted electronically, someone must leaf back

* Other assessment instruments such as student surveys and employer surveys are also utilized.

through each student exam to tally up the scores which pertain to the outcomes in question. This process will be time-consuming, and even more so when multiple outcomes must be tallied.

Since many exams and classrooms do not yet lend themselves well to electronic submission, the application of an exam cover grade sheet with exam score breakdowns can save much time in separating and tallying individual student scores pertaining to particular outcomes.

Grading sheets in engineering education literature

The use of exam or assignment grading sheets is certainly nothing new. Walvoord and Anderson's 1998 work on *Effective Grading: A Tool for Learning and Assessment*[1] redirected thought on the use of grading rubrics to specify desired outcomes, objectives, or "primary traits" expected from student work. This was considered a dual attempt to (1) encourage specific desired learning outcomes and (2) make grading more fair and efficient. V. L. Young et. al., applied Walvoord and Anderson's Primary Trait Analysis to the grading of laboratory reports in a senior capstone chemical engineering course. In addition to meeting goals (1) and (2), Young and her colleagues also noted the benefits of their grade sheets (especially in spreadsheet form) for easy compilation of performance on specific outcomes. Quadrato and Welch[3] further applied grade sheet concepts to the evaluation of a civil engineering capstone design project and noted the same three results: (1) improved student performance (largely attributed to improved communication of expectations), (2) more equitable evaluation of student work, and (3) improved ability to assess student performance of program outcomes.

More recent attention has emphasized the application and creation of rubrics to assess student work, typically breaking down expectations into component categories for hard-to-assess projects and problems and clarifying different levels of accomplishment for each category. Rubrics, in the context of this paper, might be thought of as a more rigorous form of grade sheet.

Grade sheets for exams with multiple questions

Many exams by their nature are already broken down into numerous questions. Where exam questions are already itemized and rubrics seem unnecessary, most instructors easily and equitably mark and score the exam without a grade sheet, merely assigning points alongside individual questions and problems. No cover sheet would be necessary—that is, not until the time comes to assess outcomes which might proceed from this course.

If no cover sheets exist to detail exam score breakdowns, the daunting task of gleaning assessment data from a stack of hand-graded exams involves rifling back through individual student exams to look up scores on individual problems. For this reason, exams are often overlooked as a source of assessment for multiple outcomes. The data compilation is simply too much work. However, if cover grade sheets have been filled in as part of the grading process, the itemized data is readily listed and only needs to be keyed in and manipulated.

In the case of exams which can be submitted via computer, the data entry step can be replaced with downloaded data.

Final Exam Point Breakdown - MET 230 Automated Manufacturing Systems 1

Question Number(s)			Possible Points	Points Earned	Program Outcome
1	Electropneumatic System Design			29	
1-1	Pneumatic system design Appropriate component selection/combination for desired functionality:				
a	□	Compatibility of actuator and DCV	3		A1, A2
b	□	Appropriate DCV energizing features (solenoids, spring returns)	2		A2
c	□	Appropriate pneumatic flow design (tubing connections, DCV design)	2		A1, A2
d	□	Appropriate pneumatic diagramming practice (Standard symbols, clarity)	3		A3, A2
1-2	Relay control design: Appropriate relay control design for design functionality				
a	□	Start/Extend functionality with dual start pushbuttons, latching	3		A2, A4
b	□	Stop/Retract automatic with LS1-Extended	3		A2, A4
c	□	Actuator cycle stops after first cycle	3		A2, A4
1-3	Appropriate wire diagram practice (Standard symbols and layout, clarity)				
a	□	standard symbols and layout	3		A3, A2
b	□	appropriate labeling of components	2		A3, A2
c	□	appropriate voltage specification	2		A2, A4
1-4	Parts List (documentation) - thoroughly lists components, general specifications		3		A2
2	PLC-Controlled Electropneumatic System			50	
2-1	I/O Chart (documentation; complete, separated Inputs and Outputs)		4		A2
2-2	DCV selection and depiction				
a	□	Compatibility of actuator and DCV	3		A1, A2
b	□	Appropriate DCV energizing features (solenoids, spring returns)	2		A2, A4
c	□	Appropriate symbols	2		A2, A3
2-3	PLC wiring diagram				
a	□	correct wiring	2		A2, A4
b	□	incorporates power supplies appropriately	2		A2, A4
c	□	appropriate device symbols	2		A3, A2
2-4	PLC ladder instruction interpretation (including timers and counters). (9 questions at 2.5 points each.)		27		A2, A4
2-5	Changes due to actuator design change				
a	□	Changes to pneumatic system	3		A1, A2
b	□	Changes to PLC program instructions	3		A2, A4
3	Robot Systems			21	
	Robot Programming				
3-1	□	Teaching points	3		A2
3-2	□	Continuous path programming	3		A2
	End-of-Arm Tooling				
3-3	□	Gripper Design	3		A2
3-4(a)	□	Appliance Options	3		A2
	Robot Configurations (and terminology)				
3-4(b)	□	Articulated (vertical and horizontal)	3		A2
3-5	□	Selective compliance (of SCARA)	3		A2
3-6	Robot Power Sources		3		A2
Totals:			100		

Figure 1. Exam cover grade sheet with cross reference to applicable student learning outcomes.

Information needed for outcome assessment

Figure 1 provides an example of an exam cover sheet used to break down the points issued in a final exam according to questions and competencies.

Figure 2 provides an example of assessment data desired for a particular program outcome measured within the exam. In this case, we desire to evaluate whether or not graduates are able to apply principles of applied fluid sciences. Our performance criteria states that in order to be meeting this outcome, at least 80% of the students should score 70% or better on their performance of work related to this outcome. To compute our student's performance, we need to:

(A) Isolate those questions which pertain to application of applied fluid sciences,
(B) Compute a score for each student based only on the applicable portion of the exam or other student work, and
(C) Compute the percentage of students obtaining a 70% or better on this portion of work.

Objective A. Technical Skills and Knowledge
Outcome 1. Apply principles of engineering materials, applied mechanics, and *applied fluid sciences.*
Performance Criteria 80% of the students score 'C' or better, where C is 70% of the evaluation score used by individual faculty.
Courses selected for evaluation: CET 211, *MET 230*, MET 245.
Assessment method and instrument
Assessment methods used for program assessment in the area of Technical skills and knowledge are: *Embedded questions in Exams*, Homework, and course outcomes survey.

Figure 2. Example program outcome (A1) and the role of MET 230 assessment toward this outcome.

In the example in Figure 1, the far right column references the program learning outcomes encompassed by elements of the exam, as listed in Figure 3. These indicate the scores from this exam which were then tallied to determine the level individual student performance of each key outcome and the percentage of students who performed at or above C-level. Scores from each individual student's exam score sheet were keyed into a spreadsheet, as shown in Figure 4. Additional worksheets, such as the one provided in Figure 5, were formatted to compile scores from only those exam sections related to that outcome. Similar worksheets were also made to tally scores for outcomes A2 and A3. Other courses were selected to provide more representative student performance data for outcome A4.

A. Technical Skills and Knowledge

A1. Apply principles of engineering materials, applied mechanics, and applied fluid sciences.
A2. Apply the technologies of manufacturing processes, machine design, instrumentation, and automation.
A3. Apply concepts of technical graphics, computer-aided drafting, design, modeling, and manufacturing.
A4. Understand fundamentals of applied thermal sciences, basic electronics, industrial controls, and computer programming.

Figure 3. Mechanical Engineering Technology Program outcomes summarized within the MET 230 final exam.

The major advantage of using the cover score sheet while grading the exams is simply this: when tallying manual scoring, the cover sheet eliminates the need for someone to leaf back through each student exam to extract performance data associated with isolated outcomes; the data is already itemized either on the cover sheet (or perhaps even electronically). Other advantages include:

(A) Students better understand the problem components and the nature of their own particular errors or ommisions. Cover sheets can record and communicate to students the point structure breakdown for even small problems. For example, in Figure 1, question number 1-1, a short ten-point pneumatic design problem is broken into four different competency areas (a through d).

(B) Score sheets give students a more visible picture that the scoring was assigned in a logical and uniform manner, reassuring that grading was done appropriately and equitably.

(C) The scoring breakdown and check-type sheet speeds grading, making less hand-written explanation necessary.

Obviously, computer automation which would query and build the summary statistics for the various outcomes would be a welcome improvement over manual formatting of the individual spreadsheets. However, the current spreadsheet format works well for relatively small classes and the necessary manual submission and grading of hand-sketched, open-ended design solutions.

Final Exam Point Breakdown

MET 230 Automated Manufacturing Systems 1

Student Scores

Question Number(s)	Possible Points	Program Outcome	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8	Student 9	Student 10	Student 11	Student 12	Student 13	Student 14	Student 15	Student 16
1																		
1-1																		
a	3	A1, A2	3	3	2	3	3	3	3	3	1.5	3	3	0.5	3	3	3	3
b	2	A2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2
c	2	A1, A2	2	2	0.5	0	2	2	2	2	0.5	2	2	2	2	2	2	2
d	3	A3, A2	3	1	2	0.5	3	2	3	3	3	3	3	3	3	3	2.5	3
1-2																		
a	3	A2, A4	3	3	1.5	3	3	3	3	1.5	3	3	3	3	1	3	3	3
b	3	A2, A4	3	3	1.5	3	3	3	3	3	3	1.5	0	3	3	3	0	3
c	3	A2, A4	3	3	0	3	3	3	3	0	3	1.5	3	3	0	3	0	3
1-3																		
a	3	A3, A2	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	3
b	2	A3, A2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
c	2	A2, A4	2	0	2	2	2	0	2	2	0	2	2	2	0	2	0	0
1-4	3	A2	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3
2																		
2-1	4	A2	4	4	4	4	4	3	3.5	4	4	3	4	4	4	4	3	4
2-2																		
a	3	A1, A2	3	3	3	0	3	1	1	1	3	3	3	3	3	3	1	3
b	2	A2, A4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
c	2	A2, A3	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2
2-3																		
a	2	A2, A4	2	2	0	1	2	2	2	2	2	2	2	0	0	2	2	2
b	2	A2, A4	2	2	0	2	0	2	2	2	2	2	2	0	2	2	2	2
c	2	A3, A2	2	2	1.5	0	2	0	0.5	2	2	1.5	1	0.5	1	2	2	1
2-4	27	A2, A4	24	27	24.5	25	24	27	24	24	27	27	27	23.5	27	27	27	27
2-5																		
a	3	A1, A2	3	3	1	1	3	3	2	1	3	2	0	1.5	3	3	3	3
b	3	A2, A4	3	3	3	3	3	3	2	3	3	3	0	3	3	3	3	3
3																		
3-1	3	A2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3-2	3	A2	3	3	1	1	3	3	1.5	3	3	3	3	1	0.5	3	3	3
3-3	3	A2	3	3	2	3	3	1	0	3	3	3	3	1.5	3	3	3	3
3-4(a)	3	A2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3-4(b)	3	A2	3	3	3	3	0	3	3	3	3	3	3	3	3	0	0	3
3-5	3	A2	3	3	3	0	3	0	3	0	3	3	3	0	3	0	0	3
3-6	3	A2	3	3	3	3	3	3	3	3	3	3	3	3	3	1	0	3
Totals:	100		97	96	77.5	80.5	92	87	86.5	85.5	95	94.5	90	77.5	84.5	92	77.5	97

Figure 4. Compilation and summary of individual exam scores, MET 230 Final Exam.

MET 230 Automated Manufacturing Systems 1
Spring 2005
Results from Final Exam

A. Technical Skills and Knowledge

1. Apply principles of engineering materials, applied mechanics, and applied fluid sciences

Recognize, understand, and apply key concepts, technologies, and terminology associated with basic building blocks of automated manufacturing systems: pneumatic automation components and pneumatic system design.

Student Scores

Questions	Possible Points	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8	Student 9	Student 10	Student 11	Student 12	Student 13	Student 14	Student 15	Student 16
1-1a	3	3	3	2	3	3	3	3	3	1.5	3	3	0.5	3	3	3	3
1-1c	2	2	2	0.5	0	2	2	2	2	0.5	2	2	2	2	2	2	2
2-2a	3	3	3	3	0	3	1	1	1	3	3	3	3	3	3	1	3
2-5a	3	3	3	1	1	3	3	2	1	3	2	0	1.5	3	3	3	3
Totals:	11	11	11	6.5	4	11	9	8	7	8	10	8	7	11	11	9	11
Percent:		100	100	59	36	100	82	73	64	73	91	73	64	100	100	82	100
<70%:				1	1				1				1				

76% of the students obtained 70% or better on these outcomes

Total Students 17
#"passing" 13
"failing" 4

Figure 5. Sample compilation of outcome data from student scores, MET 230 final exam.

Exam 1 Competencies and Point Breakdown
MET 314 CAD and Solid Modeling, Fall 2004

Outcomes	Question Number(s)	Possible Points	Points Earned
Part Model Practice		64	
■ Recognize, understand, and apply **key terminology** and technology associated with Computer-Aided Design and Modeling systems.	Q1-Q6	6 @ 4 pts = 36 pts.	
■ Make, justify, and evaluate modeling decisions based on design (or possibly process) characteristics and needs of multiple users.			
○ **Recognize constraints, relations, and other design intent** which is intended or suggested in a design.	Q10a, b	6	
	Q11	4	
	Q12a, b	6	
○ Plan and create model to **maintain design intent**: R Part Symmetry R Concentric holes R Supports maintain width when total part length is increased R Other Implied design intent	Part 2	15	
■ Execute good practice in parametric modeling part modeling and assembly modeling techniques using select parametric modeling platforms commonly used in industry:			
○ Use **default datums.**	Part 2	4	
○ Specify **feature sizes and location** (specification) according to design intent.		8	
○ Apply **constraints** for appropriate design construction.		8	
○ Apply appropriate **references** for feature (sketch) construction.		4	
○ Apply **feature patterning, copies, and groups** as appropriate for feature specification.		4	
○ Apply **relations** as appropriate to specify design intent.		5	
	Total		

Figure 6. Exam score sheet in which exam points are broken down by course learning objectives (called student learning “outcomes” at Kansas State University).

Exam score sheet organized by learning objectives

Figure 6 demonstrates possible variations in arrangement of an exam score sheet. In this example, exam points are distributed not necessarily per question, but rather, assigned according to course learning objective (called student learning “outcomes” at Kansas State University). A course objective can then be represented by multiple questions 10a and 10b, 11, and 12a and 12b demonstrate. Note that Exam “Part 2,” a CAD modeling problem, has points applied to two different course objectives: (1) modeling plan and creation decisions and (2) good practice in parametric modeling techniques. It happens in this case, that both these objectives would apply to the same overall program outcome (A3), but this technique could be applied to occasions in which design problem performance included multiple outcomes. For example, one design

problem could exhibit student performance of three different outcomes: applied principles of fluid science (A1), fundamentals of basic electronics (A4), and technical graphics (A3).
An advantage in sorting the grade sheet by outcomes is that point tallies are automatically sorted in the sheet. This also may clarify to students the applicability of exam problems. However, if the questions in the exam skip order too much between outcomes, the grading process itself may become more complex and experience delays.

Conclusions

One recurring theme among those of us new to assessment is the concern of the time assessment takes, wondering how we are going to fit this new task into an already over-packed schedule. Some institutions have managed to hire people to do the assessment "bookkeeping," but many faculty don't have that luxury. These sample exam grade sheets demonstrate some steps toward combining effective grading practice with the compilation of assessment data. Further computerization of the exam-taking and exam-grading steps could further streamline this process, as well as the application of automated queries to build reports on selected outcomes.

Bibliography

[1]B. E. Walvoord and V. J. Anderson, *Effective Grading: A Tool for Learning and Assessment,* San Francisco: Jossey-Bass Publishers, 1998.

[2]V. L. Young, D. Ridgway, M.E. Prudich, D. J. Goetz, B. J. Stuart, "Criterion-Based Grading for Learning Assessment in Unit Operations Laboratory." *Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exhibition*, 2001.

[3]C. Quadrato and R. W. Welch, "Grading Capstone Designs: On Time and On Target," *Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exhibition,* 2003.

Biography

JULIA L. MORSE, CEI, CMfgE, CEM, is an Associate Professor in Mechanical Engineering Technology at Kansas State University's K-State at Salina campus, teaching primarily in the areas of manufacturing, computer-aided design, and automation. Professor Morse has researched course grading systems since 2000. Current developmental interests include student recruitment and support structure for activity based learning.