A note on reporting on student learning in the division of natural sciences and mathematics

As noted in the meeting of Wednesday 02 August 2006, at term's end I will be asking for a report on learning organized by the student learning outcomes on your course outline. This report may be qualitative or quantitative and the methods of measurement and data collection I leave up to each faculty member.

I have suggested one option would be to item analyze the final examination or a representative sample of final examinations wherein the final was aligned with the outcomes on the outline.

One member of faculty noted that the numbers I reported out of MS 100 this past summer represented the course-long average. As students learned and mastered material, their average performance on each outcome should have improved.

Another member of faculty expressed an interest in a curriculum experiment that would answer the implicit question in the paragraph above: Do students improve throughout the term on a given outcome on the outline? Can this improvement be shown or tracked? Or do students learn only the material of the moment and forget what they learned in prior weeks? The faculty member is considering giving a comprehensive test on all outcomes at every testing opportunity to answer these questions. The faculty member noted that the student's final performance on all outcomes would then determine their grade – not the cumulative performance over the course of the term. This would effectively make the final examination 100% of the student's grade.

Given the above two paragraphs, I realized that in my outline aligned final from MS 100 I should be reporting the achievement on the final examination and not the average performance across the term.

I found that average performance on the outcomes on the final examination was 2% higher than the cumulative performance across the term. Of 17 outcomes tested by the final examination, the average for ten outcomes on the final examination were higher than performance during the regular term, one outcome showed no change, and six outcomes showed a drop in performance on the final. No attempt was made to determine statistical significance – the underlying small sizes have to cast doubt on significance. That said, there are hints of knowledge extinction in regards complex numbers and the solving of inequalities.

I thought I would again share what I did in the event that others wish to use this model to report on learning.

I first designed a final examination where each question could be mapped to an outcome. Thus

I started my work by finding a question that tested outcome 1a, then a question that tested 1b, and so forth.

Thus on the MS 100 outline the outcomes 1b, 1c, and 1d are:

> 1b. Solve linear, quadratic, polynomial, and radical equations.
> 1c. Perform operations with complex numbers.
> 1d. Solve linear, quadratic, polynomial, and radical inequalities.

The following is a short segment showing a sequence of questions from 1b to 1d.

5. [1b.00] Solve for x: $\frac{1+\sqrt{x}}{2}-1=\frac{2}{1+\sqrt{x}}$

6. [1c.91] Multiply the following complex numbers: $(3+i\sqrt{7})(3-i\sqrt{7})$

7. [1d.64] Solve the inequality and sketch the solution on a number line:
$-3x+7<28$

Note that I opted to include, for my own reference, the outline item being addressed in brackets. Since I had also chosen to re-use questions from term tests, I also noted cumulative performance on those items. The "00" for 1b indicates that no one successfully solved that problem on the in-term test.

After the final examination I performed an item analysis on the examination and determined the success rate on each of the above items:

Outcome	Students will be able to:	Performance
1b	Solve linear, quadratic, polynomial, and radical equations.	40%
1c	Perform operations with complex numbers.	40%
1d	Solve linear, quadratic, polynomial, and radical inequalities.	50%

On question five, 40% of the students answered the question correctly. This means 40% attained a fully correct answer, there was no "partial credit" in the item analysis. Forty percent of the students answered six correctly, and 50% answered seven correctly. Note that this represents improved performance on five and a decline in performance on six and seven.

On complication I ran into was that some outcomes were tested by more than one question on the final examination – the final had more than 17 questions. Thus I had to calculate average performance on an outcome based on the questions that addressed that particular outcome.

The result, a table of performances by outcome, is an example of the type of assessment report I have asked each division member provide to me in December:

Outc	Students will be able to:	CumP	FinalP	Diff
1_	Graph and solve linear and quadratic equations and inequalities including those with complex roots.	0.41	0.6	0.19
1a	Sketch the graph of an equation	0.52	0.5	-0.02
1b	Solve linear, quadratic, polynomial, and radical equations.	0.52	0.5	-0.02
1c	Perform operations with complex numbers.	0.66	0.4	-0.26
1d	Solve linear, quadratic, polynomial, and radical inequalities.	0.68	0.5	-0.18
2_	Evaluate and analyze functions and their graphs including combinations and compositions of functions.	0.55		
2a	Find and use slopes of lines to write and graph linear equations in two variables.	0.58	0.5	-0.08
2b	Evaluate functions and find their domains.	0.49	0.7	0.21
2c	Analyze the graphs of functions.	0.68	0.77	0.08
2d	Find arithmetic combinations and compositions of functions.	0.69	0.75	0.06
2e	Identify inverse functions graphically and find inverse functions algebraically.	0.19	0.2	0.01
3_	Sketch and analyze graphs of polynomial functions and mathematical models of variation.	0.43		
3a	Sketch and analyze graphs of polynomial functions	0.66	0.68	0.02
3b	Use long division to divide polynomials	0.75	0.8	0.05
3c	Write mathematical models for direct, inverse, and joint variation.	0.52	0.6	0.08
4_	Determine the domains of rational functions, find asymptotes, and sketch the graphs of rational functions.	0.49	0.4	-0.09
4a	Find the domains of rational functions.	0.05	0.05	0
4b	Find the horizontal and vertical asymptotes for graphs of rational functions.	0.4	0.5	0.1
4c	Recognize graphs of circles, ellipses, parabolas, and hyperbolas.	0.71	0.86	0.15
PSLO	define mathematical concepts, calculate quantities, estimate solutions, solve problems, represent and interpret mathematical information graphically, and communicate mathematical thoughts and ideas.	0.53	0.55	0.02

Note that due to my choice to also analyze tests during the term, I was able to compare performance on the final (FinalP) to the cumulative performance across the term (CumP) and calculate a differential (Diff). The astute might note that the 1b percentage varies from further above in this same report – this is the impact of multiple questions addressing 1b.

In closing I would note that there are many, many ways to get at and measure learning. Dr. Mary Allen has been on campus a couple times in the past couple of years and there have been a number of workshops and faculty meetings on assessment over the past four years. I expect to use item analysis in my MS 100 and MS 150 courses, but my SC/SS 115 course does not lend itself to such an approach. There are wholly different report will have to be generated. I am planning to report on all three of my courses, I am asking that each division member tackle only a single course.

During the term I will be asking what system you plan to use and providing whatever help and support I can in its implementation.

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