



Learning From Wrong Answers

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Goals for Assessment:



1. Find out who are students are so we can better serve them.

2. Develop an exam system which not only tests the material appropriately, but also allows us to determine the scope of student learning.

3. Look at the most common wrong answers and use them to improve our teaching methods.

Who are our students?



- Fields of Study

- Nursing (ASN and BSN): 31%
- Dental Hygiene: 11%
- Other Allied Health: 19%
- Engineering: 10%
- Biology/Biochemistry: 7%
- Chemistry: 1%

Who are our students?



- Taking Courses Elsewhere? 13%
 - At UNR? 86%
- Working?
 - 1 – 20 hours a week 20%
 - 20 – 30 hours a week 25%
 - 30 – 40+ hours a week 39%

Student Expectations



- Expected Study Time

➤ 0 – 2 hours/week	7%
➤ 3 – 6 hours/week	54%
➤ 7 – 10 hours/week	30%

- Expected Grade

➤ A	58%
➤ B	34%

Course Completion



- Fall 2006 61%
 - 147 out of 240
- Spring 2007 57%
 - 128 out of 224
- Summer 2007 89%
 - 25 out of 28
- Fall 2007* 79%
 - 179 out of 288

Developing the exam system



- Developed a set of Learning Objectives for each chapter covered in the class.

Chapter 1

Introduction: Matter and Measurement

Learning Goals Checklist



You should be able to do each of the following:

- Distinguish between physical and chemical properties and also between simple physical and chemical changes.
- Differentiate between the three states of matter.
- Distinguish between elements, compounds, and homogeneous and heterogeneous mixtures.
- Give the symbols for the elements discussed in this chapter.

Developing the exam system



- Developed a set of Learning Objectives for each chapter covered in the class.
- Determined that a pre-assessment would be developed to see what knowledge students already have.

Developing the exam system



- Exam Questions
 - Used the American Chemical Society Exams Institute Test bank for the majority of the questions.
 - Filled in remaining questions with ones similar to what full-time faculty used on past exams.
 - Selected questions in such a manner so that they match Learning Objectives for the course.

Developing the exam system



- Match the Pre- and Post- Assessment questions

Pre-

Which molecule is polar?

- BF_3
- CO_2
- CF_4
- BeH_2
- CH_2F_2

Post-

Which molecule is nonpolar?

- HCl
- CCl_4
- CF_3Cl
- CF_2Cl_2
- CFCl_3

Hake Gain¹



$$\langle g \rangle = \frac{\% \text{ correct on post-test} - \% \text{ correct on pre-test}}{100 - \% \text{ correct on pre-test}}$$

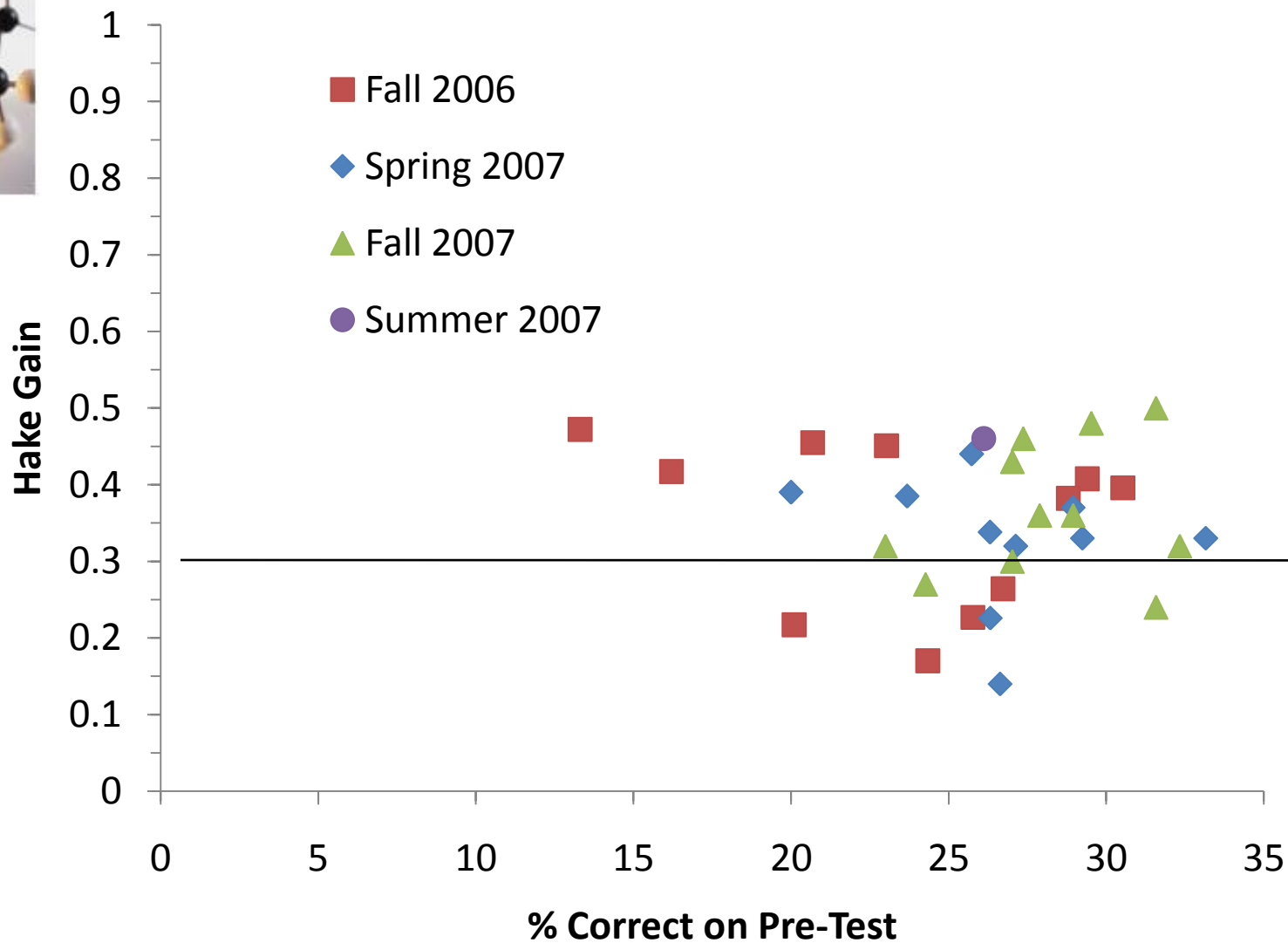
$0 < \langle g \rangle < 0.3$ “Low” gain (typical of lecture-only)

$0.3 < \langle g \rangle < 0.7$ “Medium” gain (typical of active learning)

$0.7 < \langle g \rangle < 1$ “Un-ubtanium”

¹Prather, E. E. et. al “Research on a Lecture-Tutorial Approach to Teaching Introductory Astronomy for Non-Science Majors,” *Astronomy Education Review*, Issue 2, Vol 3:122-136.

Hake Gain



Developing the exam system



- Is the question too easy or too hard?

Difficulty Index

$$p = \frac{\text{\# of correct responses}}{\text{total responses}} \cdot 100$$

ACS Exams Institute keeps questions between 30 and 70.

We aim for our questions to be between 35 and 80—average = 51.3

Developing the exam system



Question:

	Fall 2006	Fall 2007
a.	16%	10%
b.	71%	78%
c.	5%	4%
d.	5%	3%
e.	1%	4%

Developing the exam system



Question: The highest oxidation number of vanadium is exhibited in:

Question:

	Fall 2006		Fall 2007
a. VO_3^-	29%	a.	50%
b. VO^{2+}	18%	b.	15%
c. V_2S_3	12%	c.	20%
d. VBr_4	18%	d.	11%
e. VN_2^{4-}	22%	e.	6%

Developing the exam system



- Is the question a good discriminator between the lowest and the highest students?

Discrimination Index

$$r = \frac{\left[\begin{array}{l} \text{Top 1/3 students who} \\ \text{got the answer correct} \end{array} \right] - \left[\begin{array}{l} \text{Bottom 1/3 students who} \\ \text{got the answer correct} \end{array} \right]}{\text{number of students in each group}}$$

ACS Exams Institute keeps questions between 0.3 and 0.5

But for a few exceptions, we've done the same.

Developing the exam system



Question #	Top 1/3	Bottom 1/3	Discrimination Index
1	40	25	0.33
1	55	28	0.48
2	26	10	0.36
2	48	15	0.59
3	16	8	0.18
3	38	18	0.36
4	19	12	0.16
4	29	21	0.14

■ Fall 2006: 45 students

■ Fall 2007: 56 students

Developing the exam system



Question #	Top 1/3	Bottom 1/3	Discrimination Index
1	40	25	0.33
1	55	28	0.48
2	26	10	0.36
2	48	15	0.59
3	16	8	0.18
3	38	18	0.36
4	19	12	0.16
4	29	21	0.14

■ Fall 2006: 45 students

■ Fall 2007: 56 students

Learning from wrong answers



Question 2:

a. .	1%	3%
b. .	29%	12%
c. .	32%	26%
d. .	2%	4%
e. .	36%	55%

Developing the exam system



Question #	Top 1/3	Bottom 1/3	Discrimination Index
1	40	25	0.33
1	55	28	0.48
2	26	10	0.36
2	48	15	0.59
3	16	8	0.18
3	38	18	0.36
4	19	12	0.16
4	29	21	0.14

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Learning from wrong answers



Question 3: The highest oxidation number of vanadium is exhibited in:

Question 3:

	Fall 2006		Fall 2007
a. VO_3^-	29%	a.	50%
b. VO^{2+}	18%	b.	15%
c. V_2S_3	12%	c.	20%
d. VBr_4	18%	d.	11%
e. VN_2^{4-}	22%	e.	6%

Developing the exam system



Question #	Top 1/3	Bottom 1/3	Discrimination Index
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1	55	28	0.48
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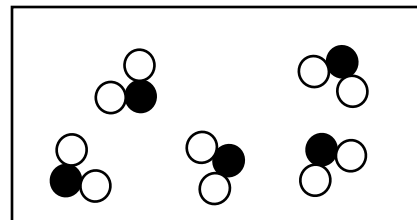
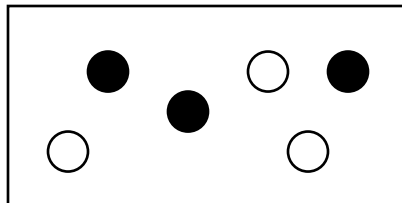
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Learning from wrong answers



Question 4: Consider the pictures below. What do these represent?



a. .

34%

b. .

1%

c. .

5%

d. .

18%

e. .

42%

Learning from wrong answers



- Question

a. . 9%

Mistake: Using the wrong conversion for mL to L and only calculating moles.

b. . 45%

Mistake: Not writing out the balanced chemical equation and finding the stoichiometric ratio.

c. . 24%

d. . 17%

Mistake: Not writing out the balanced chemical equation and switching the two volumes in the calculation.

e. . 5%

Mistake: Adding the volumes together and using the wrong conversion for mL to L.

Learning from wrong answers



- Question

a. . 7%

Mistake: Not balancing the chemical equation.

b. . 49%

c. . 27%

Mistake: Not doing a limiting reactant problem.

d. . 13%

Mistake: Just adding moles of nitrogen and oxygen together.

e. . 3%

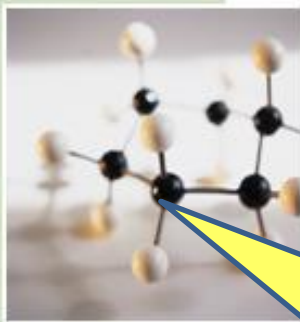
Mistake: Not using the correct formula for oxygen gas, O_2 .

In Summary



- Create questions based upon the learning objectives using both test banks and our own questions.
- Examine difficulty index (is the question too hard or too easy?) for each question.
- Examine the discrimination index in conjunction with the difficulty index (does the question discriminate appropriately) for each question.
- Examine our teaching methods and how we teach material.

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Elena Bubnova

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