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Building an Interdisciplinary Partnership to Improve Math Skills in the Science Classroom

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BUILDING AN INTERDISCIPLINARY PARTNERSHIP TO IMPROVE MATH SKILLS IN THE SCIENCE CLASSROOM

Greta A Giles and Paula H Krone

Scholarship of STEM Teaching and Learning Conference

Georgia Southern University

March 5-6, 2015

Activity: Identifying Math Skills

Identify and list on the poster board math skills with which your students have difficulty.

Collaboration Step 1: Conversation

What do you want to fix?

Where do you fix it?

Orders of magnitude and converting between metric units

Problems :Here we have difficulty with keeping track of whether the exponent should be + or –

Example...

One table may list $1 \text{ m} = 100 \text{ cm}$ while another says $0.01 \text{ m} = 1 \text{ cm}$ or another say $1 \text{ cm} = 1 \times 10^{-2} \text{ m}$. Students don't recognize these as all being the same thing! They may remember that "100" goes with centi, but then aren't sure if the 100 goes on the "top" or the "bottom" when doing dimensional analysis.

1. Convert 54 cm into meters

Correct = $54 \text{ cm} \times (1\text{m} / 100 \text{ cm}) = 0.54 \text{ m}$ or $54 \text{ cm} \times (0.01 \text{ m}/1 \text{ cm}) = 0.54 \text{ m}$

Common Mistake = $54 \text{ cm} \times (100 \text{ m}/1\text{cm}) =$ or $54 \text{ cm} \times (1 \text{ m} /0.01 \text{ cm}) =$

Scientific notation

Problems : if the exponent is + or -, how to enter in the calculator. Frequently they leave the exponent part out completely. Sometimes they insist on managing the exponents in their heads which is a bad idea. Sometimes they don't get a number back into proper scientific notation.

Examples : reporting 2.5 as an answer instead of 2.5×10^4 (usually this is because they can't read their calculators), reporting 25×10^3 instead of 2.5×10^4 , entering 2.5×10^4 in their calculator as "2.5 x 10 EE 4"

Dimensional Analysis

Problems : the concept of fractions. DA is really all about multiplying by 1. Problems putting these into their calculators and getting order of operations right. Problems working with units that are rates or that contain squares/cubes. Density problems sometimes requires calculating areas/volumes and they no longer know those equations.

Examples:

1. Convert 3.5 meters into in

Correct : $3.5 \text{ m} \times (100 \text{ cm}/1 \text{ m}) \times (1 \text{ in} / 2.54 \text{ cm}) =$

Mistake : $3.5 \times 100 \times 2.54 =$

2. Convert 3 cm/min into in/hr

Correct : $3 \text{ cm}/\text{min} \times (1 \text{ in}/2.54 \text{ cm}) \times (60 \text{ min}/1 \text{ hr}) =$

Mistakes : every possible combination of the numbers above!

3. Convert 3 cm^2 into in^2

Correct : $3 \text{ cm}^2 \times (1 \text{ in}/2.54 \text{ cm}) \times (1 \text{ in}/2.54 \text{ cm}) =$ or $3 \text{ cm}^2 \times (1 \text{ in} / 2.54 \text{ cm})^2 =$

Mistakes : 3×2.54 or $3 \times (2.54)^2$

Areas and Volumes they need : squares, cubes, rectangles, rectangular solids, circles, spheres, triangles

Significant figures

Problems: keeping track of the different between +- and */, rounding off to the correct sig figs and using zeros as place holders, sig figs when doing more than one function

1. Report 4310×1.1 to the correct sig figs

Correct 4741 rounded to 2 sig figs is 4700

Mistakes : 4740 (round to 3), 47 or 4740 (leave off place holding)'s.....frighteningly common mistake!)

2. Report $4311.3 + 2.4$ to correct sig figs

Correct 4313.7

Mistakes : 43 or 4300 (counting sig figs not decimal places)

Isotopes

Problems : using weighted averages

Examples:

78.8 % of Mg is found as Mg 24 and has a mass of 23.99264. 10.10 % of Mg is found as Mg 25 and has a mass of 24.99375. 11.10 % of Mg is found as Mg 26 and has a mass of 25.99080.

What is the average atomic mass of Mg?

The average mass of Carbon is 12.0149. If carbon only comes in two isotopes, C-12 (mass of 12.00380) and C-13 (mass of 13.00748) what percentage of carbon is C-12?

Stoichiometry

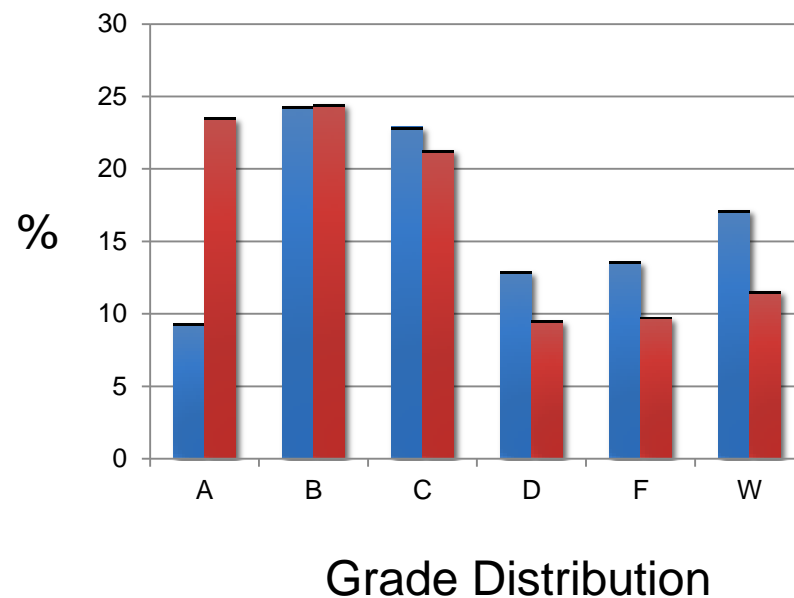
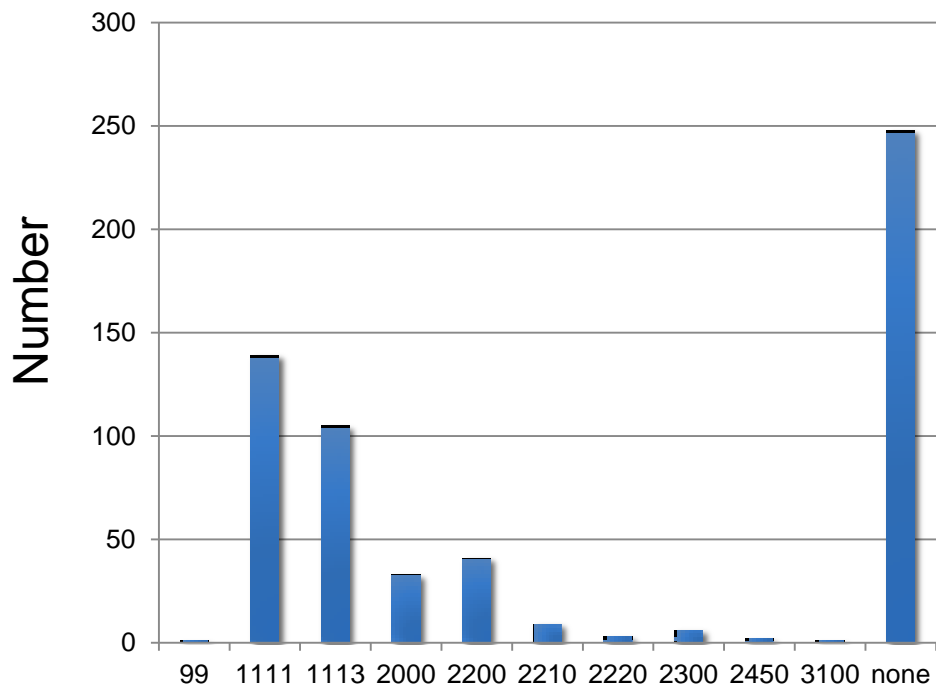
Problems : using percentages to find percent composition. Also have problems using percentages as parts of mass percent problems

Using/Reading Graphs

Primarily with gas laws and phase diagrams

Problem : graphing, having units evenly spaced on axes, using the formula for a line to calculate a point on the line,

Course Selection



Math Course taken Concurrent to CHEM 1211

Alignment Issue	CHEM 1211	MATH 1113
<p>Terminology Example: rounding to specific decimal place vs significant figures</p>	Chap 1.7	Prior Knowledge
<p>Pre-requisite equations Example: volumes and areas of common shapes</p>	Chap 1.6	Chap P.8, 1.10
<p>Calculator Use Example: using positive and negative experiments with base ten on the calculator</p>	Throughout Chap 1.6, 2.9, 7.2	Chap P.2
<p>Calculator Use Example: scatter plots</p>	Lab (Beer's Law)	Chap 1.4
<p>Solving for Variables Example: solving formula for a specified variable, particularly when in the denominator or when log/ln is involved</p>	Throughout Chap 5.4, 7.4	Chap P.7

Activity: Math Strategies

Please solve the math problems on your activity sheet, showing your work.

Then, discuss in your group the steps you took to solve them.

Activity: Math Strategies

*Please solve the math problem below, showing your work.
Then, discuss in your group the steps you took to solve it.*

$$(4.1 \times 10^5)(3.0 \times 10^{-4}) =$$

Activity: Math Strategies

*Please solve the math problem, below, showing your work.
Then, discuss in your group the steps you took to solve it.*

$$\frac{2}{50} + \frac{5}{150} =$$

Activity: Math Strategies

*Please solve the math problem, below, showing your work.
Then, discuss in your group the steps you took to solve it.*

$$4.0 \times 3.24 =$$

Activity: Math Strategies

Please solve the math problem, below, showing your work.

Then, discuss in your group the steps you took to solve it.

Solve for y:

$$\frac{A}{\frac{1}{x} - \frac{1}{y}} = z$$

$$\frac{A}{\frac{1}{x} - \frac{1}{y}} = z$$

$$\frac{A}{z} = \frac{1}{x} - \frac{1}{y}$$

$$\frac{A}{z} - \frac{1}{x} = -\frac{1}{y}$$

$$-\frac{A}{z} + \frac{1}{x} = \frac{1}{y}$$

$$\left[-\frac{A}{z} + \frac{1}{x}\right]^{-1} = y$$

method 1:

$$\frac{A}{\frac{1}{x} - \frac{1}{y}} = z$$

$$\frac{y}{xy} - \frac{x}{xy} = z$$

$$\frac{A}{\frac{y-x}{xy}} = z$$

$$\frac{Axy}{y-x} = z$$

(OR)

method 2:

$$\frac{A}{\frac{1}{x} - \frac{1}{y}} = z$$

$$\frac{A}{\frac{1}{x} - \frac{1}{y}} \cdot \frac{xy}{xy} = z$$

$$\frac{Axy}{y-x} = z$$

$$Axy = z(y-x)$$

$$Axy = yz - xz$$

$$xz = yz - Axy$$

$$xz = y(z - Ax)$$

$$\frac{xz}{z - Ax} = y$$

$$xz = y(z - Ax)$$

EXAMPLE 10 Simplifying a Complex Rational Expression

Simplify: $\frac{\frac{1}{x+h} - \frac{1}{x}}{h}$.

SOLUTION

We will use the method of multiplying each of the three terms, $\frac{1}{x+h}$, $\frac{1}{x}$, and h , by the least common denominator. The least common denominator is $x(x+h)$.

$$\frac{\frac{1}{x+h} - \frac{1}{x}}{h}$$

$$= \frac{\left(\frac{1}{x+h} - \frac{1}{x}\right)x(x+h)}{hx(x+h)}$$

Multiply the numerator and denominator by $x(x+h)$, $h \neq 0$, $x \neq 0$, $x \neq -h$.

$$= \frac{\frac{1}{x+h} \cdot x(x+h) - \frac{1}{x} \cdot x(x+h)}{hx(x+h)}$$

Use the distributive property in the numerator.

$$= \frac{x - (x+h)}{hx(x+h)}$$

Simplify: $\frac{1}{x+h} \cdot x(x+h) = x$ and

$$\frac{1}{x} \cdot x(x+h) = x+h.$$

$$= \frac{x - x - h}{hx(x+h)}$$

Subtract in the numerator. Remove parentheses and change the sign of each term in parentheses.

$$= \frac{-h}{hx(x+h)}$$

Simplify: $x - x - h = -h$.

$$= -\frac{1}{x(x+h)}, h \neq 0, x \neq 0, x \neq -h$$

Divide the numerator and denominator by h .



SOLUTION

Our goal is to isolate the variable p . We begin by multiplying both sides by the least common denominator, pqf , to clear the equation of fractions.

We need to isolate p .

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

This is the given formula.

$$pqf \left(\frac{1}{p} + \frac{1}{q} \right) = pqf \left(\frac{1}{f} \right)$$

Multiply both sides by pqf , the LCD.

$$pqf \left(\frac{1}{p} \right) + pqf \left(\frac{1}{q} \right) = pqf \left(\frac{1}{f} \right)$$

Use the distributive property on the left side and divide out common factors.

$$qf + pf = pq$$

Simplify. The formula is cleared of fractions.

We need to isolate p .

$$qf + pf = pq$$

This is the equation cleared of fractions.

$$qf + pf - pf = pq - pf$$

Subtract pf from both sides.

$$qf = pq - pf$$

Simplify.

$$qf = p(q - f)$$

Factor out p , the specified variable.

$$\frac{qf}{q - f} = \frac{p(q - f)}{q - f}$$

Divide both sides by $q - f$ and solve for p .

$$\frac{qf}{q - f} = p$$

Simplify.



Collaboration Step 2: Identifying Pedagogical Differences

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Examples

- Differences in how we do calculations with exponents

Collaboration Step 2: Identify Pedagogical Differences

Examples

- Differences in how we do calculations with exponents
- Differences in how we report answers

Collaboration Step 2: Identify Pedagogical Differences

Examples

- Differences in how we do calculations with exponents
- Differences in how we report answers
- Differences in how we solve complex algebraic equations

Student Perception

Math math \neq *Chemistry* math

- Differences in how numbers/answers are expressed
- Movement from variables x and y to P,V,T,k, etc.

Collaboration Step 3: Strategies

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- Student learning community

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- Modification to one or both courses

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- Modification to one or both courses
- Classroom observation

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- Student learning community
- Modification to one or both courses
- Classroom observation
- Team Teaching
- Other

Our approach

- Student learning community
- Modifications to both courses
- Classroom observation

Our Learning Community

- Precalculus (MATH 1113) and
Principles of Chemistry I (CHEM 1211K)
- Block scheduled
- Same students in both sections
- Coordinated faculty schedule
- Recruitment

Adaptations to Both Courses

Coordinate Schedules (Exams and Quizzes)

Clarify to students the differences in how answers are written

Reinforce study habits, problem solving strategies

Modification to MATH 1113:

Review of Rational Expressions:

- Addition/Subtraction of Rational Expressions
- Multiplication/Division of Rational Expressions
- Simplifying Complex Rational Expressions

Review of Solving Linear Equations Involving Fractions:

- Solving a Single Variable Equation when Denominators Contain Constants
- Solving a Single Variable Equation when Denominators Contain Variable Terms

Review of Solving Linear Equations Involving Fractions:

- Solving a Single Variable Equation When Denominators Contain Variable Terms
- Solving a Formula for One of its Variables

Modeling with Equations Using Applications of Geometry:

- Area/Perimeter of Square and Rectangle
- Area/circumference of Circle
- Pythagorean Theorem

Review of MATH 0099 Topics:

- Converting between Scientific and Standard Form

Chemistry Course Adaptations

- Use terminology that has been established in math classes

Example : constant of variation

- Increase use of calculators and graphical representations
- Reinforce similarities

Example : dimensional analysis and simplifying functions....

Example : isotope problems and area problems with two variables.....

Joint Assignments

- Graphing Functions/Slopes and Gas Laws
 - We can't have 0 in denominator, finding domains,
 - Shifting functions, how we get the Kelvin scale
 - Equations of variation (2.8) , combined gas law, direct variation and inverse variation
- Systems of linear equations
 - balancing reactions
 - concentrations of mixtures
 - partial pressure problems

Summary: Collaboration Steps

1. Identify what you want to fix and in what course(s) you want to fix it.
2. Identify pedagogical differences
3. Identify strategies you will use to affect changes.

Questions?

