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Dynamic CORNER

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Creating Dynamic Science Questions

Dynamic questions are the sweetest thing to reach a science teacher's desk since the laminated periodic table! I'm now able to create good dynamic questions with dynamic solutions and stretch each one across the entire scaffolding of my students' learning from class notes to reviews to quizzes and tests. And now I'm beginning to use ExamView multiple choice, true/false, and yes/no questions with MindPoint Quiz Show and eInstruction's CPS to fully engage all of my students in class (and have a lot of fun, too!).

One amazing thing is that I'm relatively new to ExamView so I know it's only going to get better--especially as I share ExamView questions and teaching ideas with other innovative teachers (like you, since you're reading this article!). I don't even want to think about the dark ages of question and test creation that I experienced before getting started with ExamView.

I encourage you to read and study the *ExamView My Way* article in the April 2003 newsletter. This article provides a primer for understanding dynamic questions. If you want to learn how to create dynamic math questions, check out the *Dynamic Corner* article in the September 2003 newsletter.

Before you begin, click here to download the following question bank (Dynamic Corner-Part II.bnk) *Windows* or (Dynamic Corner-Part II) *Macintosh*. The bank includes the sample questions. (Remember that you will need ExamView 4.0 or a more recent version.)

Example 1: Identifying the Charge on Atoms *(Bimodal Question #1)*

What is the charge on a Magnesium ion?
a. $^{-}1$ b. $^{+}2$ c. $^{-}2$ d. $^{+}1$

ANS: B
The correct answer is $^{+}2$ because Magnesium is in the first group of the periodic table.

Identifying the Charge on Atoms-Variables

What is the charge on a Element ion?
a. $^{-}$Result4 b. $^{+}$Result1 c. $^{-}$Result2 d. $^{+}$Result3

ANS: B
The correct answer is $^{+}$Result1 because Element is in the group group of the periodic table.

Identifying the Charge on Atoms-Algorithm Definitions

FirstGroupList	list("Hydrogen","Lithium","Sodium","Potassium","Cesium","Rubidium","M
WhichElement	rand(11)
Element	choose(WhichElement,FirstGroupList)
group	if(WhichElement<7,"first","second")
Result1	if(WhichElement<7,1,2)
Result2	if(WhichElement<7,1,2)
Result3	if(WhichElement<7,2,1)
Result4	if(WhichElement<7,2,1)
Scramble	TRUE

Note: To enter or edit an algorithm, double-click a question and choose Algorithm Definitions from the Edit menu.

A Closer Look at the Algorithm Definitions
Below is an explanation of the algorithms used in this question. The names you use for the algorithm definitions (or variables) are not critical as long as you do not use function names. As for the functions (e.g., list, range, choose, etc.), you can get a detailed description by reviewing the online help information in the program or by choosing the **I** button while in the Edit Algorithms\New window.

Here we have a list of six elements from group **I** of the periodic table. As such they all have a + charge. A random element is chosen and we ask, "What is the charge on *Element*?" In order to correctly answer this question, the young scientist must remember the symbol that matches the element in the question and must also know the charge on that element when it is in ion form.

- **FirstGroupList** lists all the elements to be used in the question.
- **WhichElement** generates a random number between 1 and 11.
- **Element** randomly chooses one of the 11 elements from the **FirstGroupList**.
- **group** will return the text "First" or "Second" in the Rationale area of the question, depending upon the element's location in the periodic table.
- **Result1** is the correct answer. If the element chosen is one of the first 6 elements, the correct answer will be +1; otherwise, the correct answer will be +2.
- **Result2, Result3, Result4** are three distractors for the multiple choice version of this bimodal question. The tricky part of this question, like most multiple choice questions, is that you want to include some answers that might be close to the real answer but not quite right (good distractors). This way you take away some of the lucky guessing. It's a bit more difficult to construct good distractors dynamically, and you can see that I probably didn't do a superb job of giving three answers that could be correct. Distractor #1 (**Result2**) is almost correct but has a - (minus) charge instead of a plus charge. Distractor #2 (**Result3**) contains the wrong number and the correct charge. Distractor #3 (**Result4**) will contain both the wrong number and charge.
- **isunique(Result1 … Result4)** is a condition that ensures that none of the four multiple choice answers are the same. In general, you should add this condition to every multiple choice question you create to prevent duplicate answers. (I would advise only adding it if there is a possibility that two or more answers could be the same. I never advise adding conditions that are not essential.)
- **Scramble=TRUE** causes the program to randomly scramble the answer choices each time you calculate a question.

Example 2: Identifying an Element as a Metal, Transition Metal, Nonmetal, or Metalloid
(Bimodal: Question #2)

Is ***Chlorine*** a metal, transition metal, non-metal, or metalloid?
a. metalloid b. transition metal c. nonmetal d. metal

ANS: C

Identifying an Element as a Metal, Transition Metal, Nonmetal, or Metalloid -Variables

Is ***Name*** a metal, transition metal, non-metal, or metalloid?
a. Result3 b. Result4 c. Result1 d. Result2

ANS: C

Identifying an Element as a Metal, Transition Metal, Nonmetal, or Metalloid-Algorithm Definitions

ElementsList	list("H","Li","Na","K","Be","Mg","Ca","Sc","Ti","V","Cr","Mn","Fe","Co","Ni",""
WhichElement	rand(36)
Element	choose(WhichElement,ElementsList)
NamesList	list("Hydrogen","Lithium","Sodium","Potassium","Beryllium","Magnesium",""
Name	choose(WhichElement,NamesList)
PropertyList	list("nonmetal","metal","metal","metal","metal","metal","transition metal","tra
Property	choose(WhichElement,PropertyList)
Result1	Property
Result2	choose(rand(36),PropertyList)
Result3	choose(rand(36),PropertyList)
Result4	choose(rand(36),PropertyList)
(condition)	isunique(Result1,Result2,Result3,Result4)
Scramble	TRUE

A Closer Look at the Algorithm Definitions

- **ElementsList, WhichElement,** and **Element** are *variables* used to generate a random element symbol from 36 chosen from the periodic table.
- **NamesList, Name** are *variables* used to represent and select element names. The order of the names in this list matches the order of the element symbols in **ElementsList**.
- **PropertyList, Result1** are *variables* used to represent and select properties of the elements. The order of the properties in this list matches the order of the element symbols in **ElementsList**.
- **Result2 … Result4** are the three distractors (for the multiple choice version of this bimodal question). In this case it was very easy to generate distractors since there are four possible properties for each element and only one of them is correct.
- **isunique(Result1 … Result4)** is a condition that makes sure that none of the four multiple choice answers are the same. If **isunique** were omitted, it is likely that at least two of the results would be identical, and that would invalidate the question.
- **Scramble=TRUE** causes the program to randomly scramble the answer choices each time you calculate a question.

Example 3: Identifying an Element Symbol as… *(Bimodal: Question #3)*

Is the element represented by the symbol ***Ne*** a metal, transition metal, non-metal, or metalloid?
a. metalloid b. metal c. transition metal d. non-metal

ANS: D

Identifying an Element Symbol as… -Variables

Is the element represented by the symbol ***Element*** a metal, transition metal, non-metal, or metalloid?

a. Result2 b. Result4 c. Result3 d. Result1

ANS: D

Identifying an Element Symbol as… -Algorithm Definitions

ElementsList	list("H","Li","Na","K","Be","Mg","Ca","Sc","Ti","V","Cr","Mn","Fe","Co","Ni","
WhichElement	rand(36)
Element	choose(WhichElement,ElementsList)
NamesList	list("Hydrogen","Lithium","Sodium","Potassium","Beryllium","Magnesium","
Name	choose(WhichElement,NamesList)
PropertyList	list("nonmetal","metal","metal","metal","metal","metal","transition metal","tra
Property	choose(WhichElement,PropertyList)
Result1	Property
Result2	choose(rand(36),PropertyList)
Result3	choose(rand(36),PropertyList)
Result4	choose(rand(36),PropertyList)
(condition)	isunique(Result1,Result2,Result3,Result4)
Scramble	TRUE

A Closer Look at the Algorithm Definitions

Note that the algorithm definitions are the same in the questions shown in Example 2 and Example 3. Only the question has been reworded.

Example 4: Identifying the Name of an Element *(Completion: Question #1)*

_____ is the name for the element represented by the chemical symbol ***Ca***. (Spelling counts!)

ANS: **Calcium**

Identifying the Name of an Element-Variables

_____ is the name for the element represented by the chemical symbol ***Element***. (Spelling counts!)

ANS: **Name**

Identifying the Name of an Element-Algorithm Definitions

ElementsList	list("H","Li","Na","K","Be","Mg","Ca","Sc","Ti","V","Cr","Mn","Fe","Co","Ni","
WhichElement	rand(36)
Element	choose(WhichElement,ElementsList)
NamesList	list("Hydrogen","Lithium","Sodium","Potassium","Beryllium","Magnesium","
Name	choose(WhichElement,NamesList)

A Closer Look at the Algorithm Definitions
Memorizing element symbols and their corresponding names is useful for both chemistry and biology students, so teachers try various methods to help students put these firmly into their memory banks. When it comes time to create a test, this dynamic question provides the ability to create 36 questions at the click of a button. This question uses a simple five-line algorithm to display an element's symbol in the question and asks a student to give the name. The secret here is to match up the lists of chemical symbols and names, so the order of the entries in the lists is critical. Correct spelling is emphasized because if this question is used online then students must use exact spelling or their answer will be marked as incorrect. Also notice that this single dynamic question is actually 36 questions in one! I encourage you to change it to include additional element symbols and names to make it even more powerful.

Tips: The most time-consuming part of writing a question like this is typing all of the element symbols and names in lists-while putting them in quotation marks-and making sure you don't make any spelling mistakes. So here are a couple of tips to speed this process along. These tips will work for all lists, but they are not needed for lists of numbers. Tip 1: Type the list into Microsoft Word (with commas separating) and then use Word's Replace function to replace each comma with "," (that is, a quote, a comma, and another quote). Then add a quote at the beginning and end of the list. Tip 2: Find your list in table form on the Internet and then copy and paste it into a worksheet in Microsoft Excel. Copy the table and use the Paste Special-Transpose function, if necessary. Then save it in .csv (comma separated variable) format, and then follow Tip #1 above. Either method will save you time by replacing every comma with quote, comma, quote in a matter of seconds. Then simply select, copy, and paste the new list into an ExamView algorithm.

Example 5: Identifying the Chemical Symbol for an Element *(Completion: Question #2)*

_____ is the chemical symbol for **Sulfur**.

ANS: ***S***

Identifying the Chemical Symbol for an Element-Variables

_____ is the chemical symbol for **Name**.

ANS: ***Element***

Identifying the Chemical Symbol for an Element-Algorithm Definitions

ElementsList	list("H","Li","Na","K","Be","Mg","Ca","Sc","Ti","V","Cr","Mn","Fe","Co","Ni","
WhichElement	rand(36)
Element	choose(WhichElement,ElementsList)
NamesList	list("Hydrogen","Lithium","Sodium","Potassium","Beryllium","Magnesium","
Name	choose(WhichElement,NamesList)

A Closer Look at the Algorithm Definitions

It took me less than a minute to convert Completion Question #1 (Example 4) to this question. Notice that the algorithm definitions are identical and that only the question statement and variables used in the question and answer are different. Slick, huh? Now, instead of 36 questions from one good dynamic question, we've suddenly doubled that number to 72 by duplicating a question and rewriting the question and answer. To duplicate a question, simply highlight the question and hit Ctrl+D. You can then make changes to this duplicate question.

Example 6: Stoichiometry *(Problem: #1)*

$2KMnO_4(aq) + 5CaC_2O_4 + 8H_2SO_4(aq) \rightarrow products$

Calcium ion helps blood cells with clotting. An acceptable level is 4.0-6.0 mg/dL (where dL is one tenth of a L). One way to check the concentration level is to treat 1.00mL of human blood with $Na_2C_2O_4$. The resulting precipitate is isolated and dissolved in H_2SO_4 to a final volume of 10.00mL. Then 0.5 mL of 0.00039 M $KMnO_4$ solution is used to reach a titration end point. What is the molarity of Ca^{2+} in the H_2SO_4 solution? Does this person have healthy amount of Ca^{2+} in his/her blood stream?

ANS:

First we need to convert the volume to moles of $KMnO_4$. We do this by using stoichiometry:

$$0.5 \text{ mL soln.} \times \frac{1L}{1000mL} \times \frac{0.00039 mol KMnO_4}{1L \text{ soln}} = 0.000000195 \text{ moles of } KMnO_4$$

Now we need to convert from moles of $KMnO_4$ of CaC_2O_4 titrated:

$$0.000000195 \text{ moles of } KMnO_4 \times \frac{5 mol CaC_2O_4}{2 mol KMnO_4} = 0.0000004875 \text{ mol } CaC_2O_4:$$

Next we will find the moles of Ca^{2+} in the CaC_2O_4 precipitate:

$$0.0000004875 \text{ mol } CaC_2O_4 \times \frac{1 mol Ca^{2+}}{1 mol CaC_2O_4} = 0.0000004875 \text{ mol } Ca^{2+}:$$

Finally we find the molarity of Ca^{2+} in the H_2SO_4 solution:

$$\frac{0.0000004875 mol Ca^{2+}}{10.00 mL} \times \frac{1000 mL}{1L} = 0.00004875 \text{ M } Ca^{2+}$$

Remember the key to good stoichiometry is always making sure your units cancel! To find if the person has a healthy amount of calcium ion in his/her blood stream we will need to find the concentration of Ca^{2+} in the blood in the form of mg/dL. We will begin by finding the mg of calcium ion found in the above sample.

$$0.0000004875 \text{ mol } Ca^{2+} \times \frac{40.08 g Ca^{2+}}{1 mol Ca^{2+}} \times \frac{1000 mg Ca^{2+}}{1 g Ca^{2+}} = 0.019539 \text{ mg } Ca^{2+}$$

Remember this is the mass of calcium ion found in 1.00mL of blood. We want to know the amount in one tenth of a L.

$$\frac{0.019539 mg Ca^{2+}}{1.00 mL \text{ of Blood}} \times \frac{1000 mL}{1L} \times \frac{1L}{10 dL} = \frac{1.9539 mg Ca^{2+}}{1.00 dL \text{ of Blood}} = 2 \frac{mg Ca^{2+}}{dL \text{ Blood}}$$

No, this patient does not have enough calcium ion in his/her blood.

Stoichiometry-Algorithm Definitions

a	range(.1,5,.1)
b	Range(.000244,.000488,.00005)
c	a/1000*b
d	c*5/2
f	d*100
g	d*40.08*1000
h	g*100
DynamicConclusi	If(h > 6, "No, this patient has too much calcium ion in his/her blood.", if
numsigfigs	if(a<1,1,2)
sigh	sigfig(h,numsigfigs,True)

DynamicConclusion (Complete):

```
If(h > 6, "No, this patient has too much calcium
ion in his/her blood.", if(h < 4, "No, this
patient does not have enough calcium ion in
his/her blood.","Yes, this patient has enough
calcium ion in his/her blood."))
```

A Closer Look at the Algorithm Definitions

- **a, b** are *variables* used in the question.
- **c, d,** … **h** are *variables* used in the dynamic solution.
- **numsigfigs** and **sigh** are *variables* that are used to write the answer using the correct number of significant digits.
- **DynamicConclusion** is a *variable* used for part b of the dynamic solution. DynamicConclusion is either "Yes" or "No" followed by an explanation that is also generated dynamically.

Although a stoichiometry problem of this complexity is more common in an AP or college chemistry class, I choose to include it because it's a good example of a simple dynamic question (in which only two variables are used) with a complex dynamic solution (six variables needed plus lots of equations using them).

As you can see, I spent a lot more time on the answer than I did on the question. However, I am firmly convinced that creating such questions and solutions is worth the effort. I can use such a question and solution to give class notes (or create tutorial movies) as having the complete (and correct!) solution will guide me in note-giving (and movie creation). I can also use variations of this question for homework or on assessments with step-by-step solutions instead of having to crank them out by hand time and time again (I've done enough of that already!).

This problem solution shows the conversion of units one step at a time until the correct solution is displayed. During the molding of this dynamic question I used the equation editor a lot and was very impressed. Not only is it easy to use, but also the equations come out looking perfect. When you insert an equation, the spacing is also impressive.

Conclusion

Undoubtedly, the important thing to remember in creating a dynamic solution is to make certain that it's really, really correct! I encourage you to enlist one or more colleagues in your efforts with dynamic questions and proofread each other's work as it's undoubtedly easier to spot someone else's mistake than your own!

I hope you enjoyed reading and studying this column as much as I enjoyed writing it! And I truly hope that it helps and encourages you to create your own dynamic questions and to share them with others. Feel free to drop me a line with your comments or feedback. Thanks!

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