Tools for Learning and Informative Assessment

- **Curtis Hieggelke**
  - Joliet Junior College
  - Joliet, IL
  - curth@jjc.cc.il.us

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Collaborating with

- **David Maloney**
  - Indiana University-Purdue University Fort Wayne
  - Fort Wayne, IN
- **Tom O'Kuma**
  - Lee College
  - Baytown, TX

Viewpoint

- **Approach is based, in part, on research on how students learn and think.**
- **Ease-of-use impacts acceptance and implementation.**
- **Small incremental changes are less stressful and more acceptable.**
- **Using alternative learning task formats is productive in promoting and assessing learning**

Alternative Learning and Informative Assessments

- **called TIPERs (Tasks Inspired by Physics Education Research) in physics**
- **inspired by the insights provided by research into students' reasoning and thinking**
  - **good research tasks and questions often make good instructional and assessment materials**
- **provide tasks that address the same ideas and issues in a variety of different ways**
  - **asking students the same or nearly the same question in many different ways helps them build deeper and more robust understanding and provides a (limited) way to measure it**

Tools for Learning

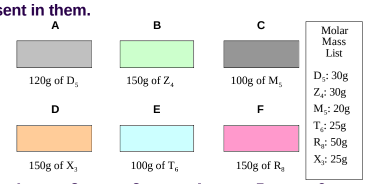
- **easy to build a sequence of related tasks targeting a specific area or difficulty**
- **employed as learning activities for**
  - **in-class work for individuals, discussions, cooperative groups, peer collaborations, preview, and review**
  - **out-of-class work related to laboratory pre- and post-work, homework, and online work**
  - **research into student models or ideas**
  - **creative work for faculty and students by having them develop new ones**

Tools for Informative Assessment

- **sequenced or alternative task formats may be used for an assessment of a specific area or concept**
- **provides a way to measure "understanding" by posing same (or almost the same) questions using various alternative formats**
- **can be used as diagnostic tools for pre- and post-instruction**
- ***Magnetism Assessment Tool* (new, pilot testing in 2002) uses 7 situations with 40 questions that employ a linked multiple choice format**
- **multiple correct answers raise grading issues for some formats**
  - **Case I - any correct answer makes it correct**
  - **Case II - all correct answers must be listed**

Chemistry Ranking Task Example

Rank these containers on the basis on the TOTAL number of atoms present in them.



Greatest 1__ 2 __ 3__ 4__ 5__ 6__ Least

Or, all of these containers have the same number of atoms.___

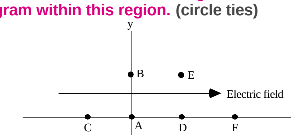
Please carefully explain the reasoning for your ranking.

How sure were you of your ranking? (circle one)

Guessed 1 2 3 4 5 6 7 8 9 10 Very Sure

Uniform Electric Field Ranking Task

We have a large region of space which has a uniform electric field in the x direction. Rank the electric field from greatest to least, at the points in the diagram within this region. (circle ties)



Greatest 1__ 2 __ 3__ 4__ 5__ 6__ Least

Or, all of the points have the same electric field.___

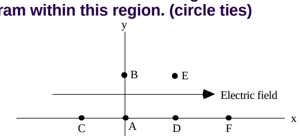
Please carefully explain the reasoning for your ranking.

How sure were you of your ranking? (circle one)

Guessed 1 2 3 4 5 6 7 8 9 10 Very Sure

Uniform Electric Field Ranking Task-Answer

We have a large region of space which has a uniform electric field in the x direction. Rank the electric field from greatest to least, at the points in the diagram within this region. (circle ties)



Greatest 1_ 2_ 3_ 4_ 5_ 6_ Least

Or, all of the points have the same electric field._X_

Please carefully explain the reasoning for your ranking.

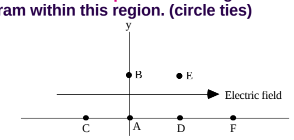
Uniform means the same everywhere

How sure were you of your ranking? (circle one)

Guessed 1 2 3 4 5 6 7 8 9 10 Very Sure

Uniform Electric Field Ranking Task-Electric Potential Answer Key

We have a large region of space which has a uniform electric field in the x direction. Rank the electric potential from greatest to least, at the points in the diagram within this region. (circle ties)



Greatest 1 C 2 AB 3_ 4 DE 5_ 6 F_ Least

Or, all of the points have the same electric field.__

Please carefully explain the reasoning for your ranking.

Potential decreases in field direction with no change perpendicular to it

How sure were you of your ranking? (circle one)

Guessed 1 2 3 4 5 6 7 8 9 10 Very Sure

Ranking Tasks (RT)

- provide a set of variations of a situation with the task to rank these variations on the basis of a specified quantity and
- also explain the reasoning scheme along with a confidence rating for the ranking sequence
- engages students in a comparison reasoning process

Ranking Task Exercises in Physics

edited by T. O'Kuma, D. Maloney, & C. Hieggelke
Prentice Hall Series in Educational Innovation (2000)

Learning and Informative Assessment Task Formats I

- Ranking Tasks (RT)
- Working Backwards Tasks (WBT)
- What, if anything, is Wrong Tasks (WWT)
- Troubleshooting Tasks (TT)
- Conflicting Contentions Tasks (CCT)
- Linked Multiple Choice Tasks (LMCT)
- Bar Chart Tasks (BCT)
- Knowledge Organizational Tasks (KOT)

Learning and Informative Assessment Task Formats II

- Predict and Explain Tasks (PET)
- Changing Representations Tasks (CRT)
- Concept Oriented Demonstrations Tasks (CODT)
- Meaningful, Meaningless Calculations Tasks (MMCT)
- Qualitative Reasoning Tasks (QRT)
- Desktop Experiments Tasks (DET)
- Concept Oriented Simulations Tasks (COST)
- Comparison Tasks (CT)

Working Backwards Tasks (WBT)

- provide information such as an equation (with values and units) or a diagram or graph —then the task is to construct a situation for which the equation or diagram or graph would apply
- reverses the order of the problem steps
- a "Jeopardy" style problem:
  what is the question (or previous step) if you know the answer (or the next step)
- requires students to reason about these situations in an unusual way
- often allows for more than one solution

Working Backwards Task Example

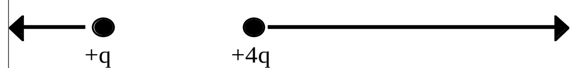
Three resistors and a battery are connected together to make several circuits. The chart below shows the values for the resistors (in ohms) and the currents (in amperes) through each resistor. For the first case the voltage of the battery is also given. (Voltages in volts.)

For all the circuits draw the circuit diagram, and for the last three circuits determine the voltage of the battery also.

	R_1	R_2	R_3	I_1	I_2	I_3	V
A	10	10	10	1.0	1.0	1.0	30
B	10	10	10	1.0	0.5	0.5	?
C	5	10	15	1.5	0.75	0.5	?
D	5	5	10	3.0	2.0	1.0	?

What, if anything, is Wrong Task (WWT) Example

Shown below are the Coulomb forces acting on two differently charged (q and 4q) small objects.



What, if anything, is wrong with this diagram? If something is wrong, explain the error and how to correct it. If the diagram is okay explain what is happening and why it works that way.

What, if anything, is Wrong Task (WWT)

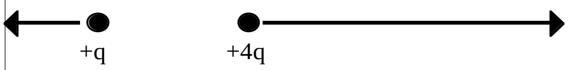
- provide a situation with the task of analyzing it to determine if it is correct or not
- if everything is correct, the student is asked to explain what is going on and why it works as described
- if something is incorrect, the student has to identify the error and explain how to correct it
- provide insights into students ideas since they often have interesting reasons for accepting incorrect situations and for rejecting valid ones
- provide ideas for other task items

Troubleshooting Tasks (TT)

- provide information that there is an error in a situation with the task of determining what the error is and explaining how to correct it
- variations on the "What, if anything, is wrong" tasks
- often produces interesting insights into students' thinking because they will at times identify some correct aspect of the situation as erroneous
- helps develop additional robust TIPERs

Troubleshooting Task (TT) Example

- Shown below are the Coulomb forces acting on two differently charged (q and 4q) small objects.



- There is something wrong with this diagram. Please explain how to correct it.

Conflicting Contentions Tasks (CCT)

- provide two, three or more, statements which disagree in some way with each other with the task to decide which contention one agrees with, if any, and explain why
- very useful for contrasting statements of alternate conceptions for a situation
- need to use real students statements to make these contentions sound authentic
- compliment the "What, if anything, is wrong" tasks.

Conflicting Contentions Task (CCT) Example

Consider the following statements made by two students.

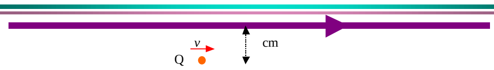
- Student I: "Because electrons can move readily in conductors but not in insulators only conductors can have a net electric charge on them."
- Student II: "Both conductors and insulators can have net electric charges on them, but the distribution of the charges will be different."

Which, if either, of these students do you believe is correct? Explain fully why you chose as you did.

Linked Multiple Choice Tasks (LMCT)

- provide descriptions of variations of a situation and the task is to choose from a set of possibilities
- use one set of possibilities (answers) for a sequence of questions about the same situation
- get both the student's answer to a particular question and their pattern of responses for the variations
- allow for the connections on how strong and weak students think about various aspects and/or variations of a situation

Linked Multiple Choice Task (LMCT) Example



- As shown in the figure, a charged particle is initially located a short distance from a long straight wire that is carrying a current. The particle is moving initially parallel to the wire.
- Descriptions of a number of changes in this situation are presented below. How does each change affect the initial acceleration of the charged particle, if at all?
- The possible answers are:
- A. This change would not affect the initial acceleration.
- B. This change would increase the magnitude of the initial acceleration but not affect its direction.
- C. This change would decrease the magnitude of the initial acceleration but not affect its direction.
- D. This change would alter the direction of the initial acceleration but would not affect its magnitude.
- E. This change would alter both the magnitude and direction of the initial acceleration.
- *Each change below refers to the original situation stated above:*
  The charge on the particle is doubled. _______
  The mass of the particle is doubled. _______
  The initial velocity of the particle is doubled. _______
  The wire is moved farther away from the charged particle. _______

Bar Chart Tasks (BCT)

- histograms used for various quantities
- often histograms are given for the before and after case of some process with a bar missing and the task is to complete the bar chart by supplying the value for the missing quantity
- most students seem to adapt to bar chart representations relatively easily
- the task of translating between another representation and this one is usually productive in measuring or developing a better understanding

Predict and Explain Tasks (PET)

- a situation is set up where some event is about to occur and the task is to predict what will happen in the situation and explain why that will occur
- tasks are situations with which students have sufficient background to enable them to understand the situation
- common format for "guide-inquiry" labs

Changing Representations Tasks (CRT)

- translate or move from one representation to another
  - -between electric field graphs and electric potential graphs
  - -between free-body force diagrams and equations for Newton's Second Law in component form for the x- and y-direction
  - -between velocity-time graphs and acceleration-time graphs
- assists in understanding the role and value of various representations and their relationship to each other and problem solving
- to go back and forth between different representations helps develop an understanding of each representation
- task can serve as a bridge between understanding and traditional problem solving since representations include mathematical relationships

Knowledge Organizational Tasks (KOT)

- students are not asked to solve a problem but may be asked for example to identify the knowledge or quantities needed to solve it, to list the principles or laws that will be used, or to organize the information that is known and unknown
- the description of the problem may be complex or vague
- students might be given the steps to solving a problem in random order and they are required to place them in a correct sequence
- might involve filling in a chart or designing a chart for the problem

Concept Oriented Demonstrations Tasks (CODT)

- involve actual demonstrations but makes them interactive
- students do much of the description, prediction and explanation
- narrow in scope and typically use very simple equipment (could use computer to display graphs of data)
- used where it is easy for students to make predictions about what will happen
- often employ demonstrations which produce unexpected results

Meaningful, Meaningless Calculations Tasks (MMCT)

- present an unreduced expression for a calculation for a quantity for a situation
- problem is to decide whether the calculation is meaningful (i.e., it gives a value which tells us something legitimate about the situation) or is meaningless (i.e., the expression is a totally inappropriate use of a relation)
- should not be trivially meaningless such as substituting a wrong numerical value into the expression

Qualitative Reasoning Tasks (QRT)

- a variety of forms with a task analysis that is qualitative
- often presented with an initial and final situation and asked how some quantity, or aspect, will change
- qualitative comparisons (e.g., the quantity increases, decreases, or stays the same) are often the appropriate answer
- frequently contain elements found in some of the other task formats (e.g., different qualitative representations and a prediction or explanation)

Comparison Tasks (CT)

- task is to make a decision on whether a quantity in one situation is greater than, less than, or equal to that quantity in a second situation along with their reasoning
- situations may be complicated or difficult but they can be answered without detailed equations and computations.
- useful in eliciting student ideas about underlying concepts.
- sequence of related comparison tasks can help in connecting or bridging related concepts and provide for information for assessing and/or guiding future instruction.

Desktop Experiments Tasks (DET)

- involve students performing a demonstration at their desks or at home
- uses a predict and explain format but adding the step of doing it
- followed by the reformulating step where students reconsider their previous explanations in light of what happened.
- narrow in scope, usually qualitative in nature, and use simple inexpensive equipment
- task sheets used to guide and focus students attention on important aspects of the situation

Concept Oriented Simulations Tasks (COST)

- involve a “real-time” computer simulation or Physlet of a situation
- can be done either in class using a computer projection system like the Concept Oriented Demonstrations (COD) or at individual computer stations similar to the Desktop Experiments Tasks (DET)
- focused but requires software and computer systems
- should be used where it would be difficult or impossible to actually do or see the results