Increasing Student Engagement by Modifying Tasks

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https://tinyurl.com/y2qd8uyy
Description of presentation from program:

Modifying existing science tasks and activities to increase cognitive demand can also increase student engagement. Student teachers at Oakland University will share examples of their work to modify existing science activities and present cases demonstrating how to incorporate NGSS science and engineering practices in these efforts.
Outline

1. How to modify tasks

2. How modifications lead to increased engagement

3. Examples of modified tasks

4. Activity
Resources related to this presentation

5 Practices for Orchestrating Productive Task-Based Discussions in Science

Ambitious Science Teaching
Three common types of science tasks to consider:

1. **Experimentation tasks**: students design, critique, or carry out an experimental protocol.

2. **Data representation, analysis, and interpretation tasks**: students interpret, analyze, and represent data.

3. **Explanation tasks**: students provide explanations for patterns or phenomena.
Where do I start when modifying tasks?

● Setting goals!
  ○ Set learning goals: what will students know or understand as a result of instruction.
  ○ Set performance goals: what will students be able to do as a result of instruction. This should be observable and measurable.
Modifying tasks to Increase Cognitive Demand

The goal of modifying tasks is to increase the cognitive demand of the task.

What to look for when identifying cognitive demand level of a task:

<table>
<thead>
<tr>
<th>Low Cognitive Demand Tasks</th>
<th>High Cognitive Demand Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Stating answers without explanations or justifications</td>
<td>● Investing significant effort in making sense of a scientific phenomena</td>
</tr>
<tr>
<td>● Using an algorithmic approach</td>
<td>● Making choices about strategies to be used to solve problems</td>
</tr>
<tr>
<td>● Following highly specified / ‘cookie cutter’ instructions</td>
<td>● Justifying choices made about approaches to problems</td>
</tr>
<tr>
<td>● Answering specific questions about data</td>
<td>● Making decisions about how to perform labs and represent data</td>
</tr>
<tr>
<td>● Repeating factual knowledge previously learned</td>
<td>● Comparing / contrasting</td>
</tr>
<tr>
<td>● Student is not making choices about how and what data to collect</td>
<td>● Critiquing</td>
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<td></td>
<td>● Describing patterns and trends</td>
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</tbody>
</table>
4 Things to Focus on When Modifying Tasks:

1. **Eliminate or minimize prescriptive directions:** Do not provide a highly detailed set of steps for students to follow. Instead, allow them to make decisions about what steps to take themselves.
   a. Ex: Giving students data and letting them decide which data to represent, how to transform the data and/or how to best represent the data so that it supports their claim.

2. **Provide complex data:** Ask students to analyze data using mathematical tools to find patterns. Provide data that is not useful or relevant and have students decide what is important and how to represent it.

3. **Give students an audience:** Provide students with an opportunity to present their work and critique the work of their peers. Increases cognitive demand by forcing students to consider the linguistic and representational choices they are making as well as by making connections to the work of their peers.

4. **Re-sequence tasks:** Instead of doing the traditional lesson and then a lab, do the lab first so that students are forced to make sense of what is going on rather than looking for what they know should happen.
How does modifying tasks increase student engagement?

- **Minimizing prescriptive instructions** allows students to have more voice and choice in what they are doing in class.
  - When students have choices in class they have a sense of ownership and partnership in their learning.
  - Students are more likely to be engaged when they are given the ability to decide how they want to learn.

- **Providing complex data** makes students engage by sorting through and making decisions about which data best supports their claim and how they should represent the data.

- **Giving students an audience** increases engagement by giving the assignment another dimension of purpose.
  - Ex: PSA, peers, etc.

- **Re-sequencing lessons** can provide students with opportunities to experience phenomena in the lab and make predictions and explanations about what is happening. Sparking curiosity in the beginning of a unit helps keep students engaged throughout the unit as they develop explanations for the phenomena.
Some Examples of Modified Tasks
History of the Atom

J.J Thomson Cathode Ray Tube Experiment
The original curriculum suggested that students do a research project on the different models of the atom and the scientists that proposed these models.

I felt that the process of doing the research was not as engaging as I would like it to be, so I wanted to try something new.

2. Web research on model development

**Assignment**
Have students do the background research that will enable them to:
1. draw the models of the atom proposed by Thomson, Rutherford and Bohr
2. state the problem with each of the previous models
3. describe the experimental evidence that led to a change in the previous model
4. recognize which features of the new model were supported by the evidence
5. recognize which features of the new model were “invented” to complete the model
Learning Goals Addressed

● Learning Goal- Students will understand the Thomson Model of the atom and how this model came to be.

● Performance Goal- Students will be able to explain how the electron was discovered and how that changed the current model of the atom.
My focus.... Providing Complex Data

- Scientists, like J.J. Thomson, make sense of patterns in data.
- Online simulations of electrical discharge tubes provide the opportunity for students to begin to connect evidence with the model that Thomson proposed.
- This kind of cognitive work—connecting claims with data—is enhanced by the modifications I made to the original task.
Crookes Tube-
“Experiment with a simulated Crookes tube for qualitative results similar to Thomson's experiments in which the electron was discovered.”

Exploring Electron Properties-
“When J.J. Thomson first discovered that a cathode ray was actually a particle beam consisting of a stream of electrons, he concluded that these new particles were not just another type of atom. Explore and compare the behavior of electrons vs. charged atoms when they are shot through an electric field of varying intensity”

# Modifications to Increase Cognitive Demand

<table>
<thead>
<tr>
<th>Original (Low CD Tasks)</th>
<th>Modified (High CD Tasks)</th>
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<tr>
<td>● Web research on model development</td>
<td>● Simulation Activity</td>
</tr>
<tr>
<td>● Background research tells all</td>
<td>● Limited background information given to students</td>
</tr>
<tr>
<td>● Prescriptive directions given on research as to what Thomson did and concluded.</td>
<td>● Took away directions as to what Thomson did and his results.</td>
</tr>
<tr>
<td>● Multiple Choice questions given to assess understanding</td>
<td>● Students completed a simulation and collected data and analyzed it as Thomson himself did.</td>
</tr>
<tr>
<td></td>
<td>● Took away multiple choice options and made questions fill in the blank or short answer.</td>
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</table>
4. Describe the path of the ray travelling out of the electrode. Draw a picture of your result. Include the charged plates in your drawing.

- Adjust the charge on the horizontal plates to the settling in the picture below.

5. How does the path of this ray compare to the last ray?

- Repeat steps 2-5 but have the DISPLAY PARTICLES setting on.

6. Using the information you collected in questions 1-5 and the observations of the particle behavior, can you tell me about the charge of that particle? Explain using results from the simulation.

the particles are negatively charged bc they always bend towards the positive side & opposite charges attract.

1. Using the charged atom sliding bar, send a positive Hydrogen, Lithium, and Carbon out of the tube. Draw what happened in the image below. Be sure to label which path is for which ion.

- Using the charged atom sliding bar, send a positive Hydrogen, Lithium, and Carbon out of the tube. Draw what happened in the image below. Be sure to label what each atom is.


The atoms deflect towards the negatively charged plate. Hydrogen deflected the most sharply, the lithium and carbon deflected at the shallowest angle.
Next time modifications

- Give students an Audience
  - Students are to imagine that they are writing a "Press Release" for Thomson's lab about the results of his Crook's Tube experiments.
  - Press Release would have to briefly and clearly explain what Thomson has achieved, how it was different from what was considered to be true, and why it is significant.
Ionic Bonding with Lewis Structures
Activity Before Modification

- Determining # of ions needed to form ionic compound.
- Coloring, cutting out puzzle pieces with images of ions, fitting together and gluing onto a poster board.
- Completing worksheet using glued together puzzle pieces.
Ionic Bonding Cut-Outs and Periodic Table Coloring Worksheet

1. Use your puzzle pieces to combine the following ions to show how they make a compound. Write down the chemical formula for the final compound.

   Remember: Positive ion is written first, negative ion is second! Include subscripts to show the number of atoms!

   
   \[
   \begin{array}{ccc}
   H^+ & F^- & Be + O^- & Be^+ & I^- \\
   Al^+ & N^- & Al^+ & P^- & Li^+ & P^- \\
   Li^+ & F^- & Li^+ & Br^- & Ca^+ & O^- \\
   Ca^{+2} & S^- & H^{+1} & O^- & Al^+ & N^- \\
   Al^{+3} & Br^- & K^+ & Cl^- & K^+ & I^- \\
   Mg^{+2} & S^- & K^+ & S^- & Rb^+ & I^- \\
   Rb^+ & Br^- & H^+ & Cl^- & \end{array}
   \]

2. What happens to the total charge of the compound after the ions bond together? (Hint: add together the charges of the ions in the compound).

3. How many lithium ions are required to bond with one nitrogen ion? Why?
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<tr>
<td>• Coloring, Cutting, Gluing puzzle pieces to put together ionic compounds</td>
<td>• Generating Lewis-Dot diagrams to see how various ions fit together to form ionic compounds</td>
</tr>
<tr>
<td>• Time wasted on tasks with no learning goal</td>
<td>• Creation of an artifact to be used for a learning activity</td>
</tr>
<tr>
<td>• No understanding of the origin of chemical properties</td>
<td>• Effective use of time creating “puzzle pieces” by addressing an additional learning target</td>
</tr>
<tr>
<td>• Fitting together puzzle pieces with no understanding of how ions are formed</td>
<td>• Reduction of formal direction</td>
</tr>
<tr>
<td></td>
<td>• Addressing NGSS standard!</td>
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</table>
Learning Goals Addressed

● Covers NGSS standard HS-PS1-1
  ○ “Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.”

● Students can generate Lewis-Dot diagrams of elements on the periodic table, and can determine the ions formed based on the octet rule.

● Students can provide the chemical formula of ionic compounds based on ions formed through the octet rule.
In Practice
Lewis-Dot “Puzzle Pieces”
Next Time Modifications?

- Provide students opportunities to generate their own ionic compounds
  - Students were given many of the elements necessary for compounds
  - Selecting their own ions to make a compound NOT found on the worksheet
- Make activity a paired assignment
As experienced teachers, do the ideas presented resonate with what you do in your classroom?

What possible challenges do you foresee with trying to modify tasks?
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Activity
- Which elements of these tasks are low cognitive demand? Which are high cognitive demand?

- How would you modify one of these tasks to increase cognitive demand?