Teaching Methods and Resources to Help Assess Student Learning
Margaret Hoeger

- Teacher at Washington International School
- Teach Grade 9 Conceptual Chemistry and IB HL/SL Chemistry
- She/Her/Hers
Formative Assessments

- Drawing Exit Tickets
- Note-Taking Thinking Routines
Drawing Exit Tickets

- Idea came from an Edutopia article I read
- Research has shown that drawing pictures reinforces memory more than written notes (Fernandes)
- Drawing the pictures requires imagining the image in your head, planning how you will draw then physically draw it.
- Use more parts of the brain and body
Drawing Exit Tickets

- During the last 5-10 minutes of class, I ask the students to summarize the lesson with an image of what they learned during the lesson.
- Students may use words to highlight what they draw, but the focus is on the image.
- In retrospect, maybe prepare them for this at the beginning of class.
Drawing Exit Tickets Goals for Student and Teacher

**Goals for Student**
- Students think about how they are going to summarize throughout the lesson
- Informs the student of their learning
- Provides another tool for them to summarize what is learned
- Becomes a habit

**Goals for Teacher**
- Highlight different ways of thinking and learning in the next lesson
- Provides me with another tool to see their level of understanding
  - Differentiated instruction follows
Exit Tickets for Classification of Matter

- Spent the lesson defining different types of matter, discussing examples and drawing matter at the atomic level.
- Then told students to summarize what they had learned.
- Looked at all of the exit tickets.
- Scanned best examples into a pdf to project next class.
- Discussed the samples next class.
- Spoke to individuals as well following class.
- Giving individuals a chance to shine who may not get that opportunity.
Exit Tickets for Classification of Matter

- Similar to some of the drawings that we discussed.
- Asked the students what they thought of this exit ticket.
- WAIT: Why Am I Talking
- Highlighted to the class everything that I liked about this exit ticket.
Exit Tickets for Classification of Matter

- Discussed diatomic molecules versus monoatomic atoms.
- Student understood that concept well.
- Student’s creativity brought a lot of joy to me.
Exit Tickets for Classification of Matter

- Asked the students what they thought of this image.
- Strengths and weaknesses
- Student wasn’t able to differentiate between homogeneous (aqueous solution) and a heterogeneous mixture (where the two components don’t mix)
- Met with student after class to iron out any misconceptions
Exit Tickets for Classification of Matter

Takeaways

- Use the exit tickets the next day as a Warm Up.
- Refreshes what they learned the previous day.
- Students write down any strengths or weaknesses from images
- Students discussing ideas
  - WAIT: Why Am I Talking, Ron Ritchhart
- I express that we aren’t judging quality of images or ideas, but having images solidify ideas and clear up misconceptions
Drawing Exit Tickets (Enthalpies of Formation Vs. Bond Enthalpies)

Asked students to compare calculating Enthalpies of Reaction from Enthalpies of Formation and from Bond Enthalpies with an exit ticket after two days of lessons on these concepts.
Drawing Exit Tickets (Enthalpies of Formation Vs. Bond Enthalpies- Hess’ Law)

- Student shows Bond Enthalpies then Hess’ Law Diagram
- Diagram isn’t drawn to perfection, but I can see a lot of concepts are clear to them.
- Like the use of symbols without using chemical symbols.
- Use this example in my notes when I teach this to other groups.
Drawing Exit Tickets (Enthalpies of Formation Vs. Bond Enthalpies)

- Love the creativity and originality of drawings while reinforcing the ideas.
- Art and Science: Using more part of the brain creating greater memories.
Drawing Exit Tickets (Bond Enthalpies)

- Thought that the student had missed the point initially.
- Realized the student focused on a single point of Average Bond Enthalpies.
- Didn’t talk about calculating enthalpies of reaction from enthalpies of formation
  - Maybe have student complete rest of exit ticket at home and bring it in as an entrance ticket,
- ChemEd Elbow partners
Drawing Exit Tickets (Enthalpies of Reactions)

- Student makes an esoteric concept relevant to herself
Drawing Exit Tickets (Enthalpies of Formation Vs. Bond Enthalpies) Takeaways

- Love the originality and creativity
- Images can be used for later classes in my notes or projected in class.
- Surprising what student find important
- If students don’t have enough time, have them complete ticket at home and bring it in as an entrance ticket.
- ChemEd participants suggested elbow partners to explain to another student what was drawn
  - Walk around room to see images
  - Have students volunteer to project to class
- Not something I do everyday, but once a cycle or once a week.
Drawing Exit Tickets Examples (Mass Spec)

Asked students to summarize what they learned about Mass Spectrometry with an exit ticket.
Drawing Exit Tickets Examples (Mass Spec)

- Creative
- Showed me that student understood process
Drawing Exit Tickets

Examples (Mass Spec)

- Student was obsessed with electron pounding molecule to form an ion
- Asked students of strengths and weaknesses of drawing.
- Students have a limited time to draw and I expect mistakes.
- Highlight risking and originality
Drawing Exit Tickets (Mass Spec)

- Notes or no notes?
- Summary of work that they can use to study later.
- Hand out the exit tickets at the end of the unit
  - Another teacher at the ChemEd presentation suggested that these could be “cheat sheets” that students could bring into tests or quizzes at the end of a unit
Drawing Exit Tickets (Mass Spec) Takeaways

- Students are limited on time and are bound to make mistakes
- Highlight risk taking and originality
- Clear up misconceptions
- Hand back exit tickets at the end of the unit
  - May be used for quiz or test
- No notes or notes when drawing exit tickets?
Draw your own exit ticket for what you have learned so far

- Was it a struggle?
- Is it comprehensible?
- How did it feel?
Note Taking Thinking Routines

- Pathways to Understanding: Developing Students’ Memory & Note Taking Skills by Ron Ritchhart
- Thinking Routines were developed by Ron Ritchhart from Harvard’s Project Zero’s Visible Thinking
- Increasing comprehension through active processing versus just copying down notes
- Handout with Note Taking Thinking Routines can be found in DropBox
- A lot of content and Thinking Routines can be found on the Project Zero website as well as Ron Ritchhart’s website or his book Visible Thinking
Note Taking Thinking Routines

- NDA: Name-Describe-Act
- Make Note
- +1 Routine
NDA: Name-Describe-Act

- Look silently at the diagram for 1-2 minutes.
- Take away the image
- Name all of the facts, parts or aspects
- Describe each of these parts, adding detail and descriptive language
- Explain how all of the parts work together
NDA and Hess’ Law

- Thinking Routines can be modified
- Chose to focus on details not memorization for a given amount of time
NDA: Name-Describe-Act

Useful for complicated systems like Hess’ Law Cycle

\[
\Delta H_c + \Delta H_f(C_2H_6) = 2 \times \Delta H_f(CO_2) + 3 \times \Delta H_f(H_2O)
\]

\[
\Delta H_c = 2 \times \Delta H_f(CO_2) + 3 \times \Delta H_f(H_2O) - \Delta H_f(C_2H_6)
\]

\[
\Delta H_c \leq \Delta H_f(Products) - \Delta H_f(Reactants)
\]
NDA and Hess’ Law

\[ \text{C}_2\text{H}_4 + 3\text{O}_2 \overset{\Delta H}{\longrightarrow} 2\text{CO}_2 + 3\text{H}_2\text{O} \]

\[ \Delta H_C = 2 \times \Delta H_f (\text{CO}_2) + 3 \times \Delta H_f (\text{H}_2\text{O}) \]

\[ \Delta H_C = \Delta H_f (\text{Products}) - \Delta H_f (\text{Reactants}) \]

Name Describe Act

Name

Describe

Act

Name Describe Act

Name: Name and make a list of all of the parts or features you can remember.

Describe: For each of the things you have named, add a description.

Act: For each of the things you have named, tell how they act. What are they doing? What is their function? How do they add or contribute to the whole?
NDA and Hess’ Law

● In the previous class, we looked at Hess’ Law in terms of simultaneous equations and Hess’ Law Cycle
● Objective of this lesson was to incorporate using enthalpies of formation to find the enthalpy of reaction
# NDA and Hess’ Law Students’ Work

<table>
<thead>
<tr>
<th>Name</th>
<th>Describe</th>
<th>Act</th>
</tr>
</thead>
</table>
|      | - combustion reactions  
    | - reactants, products  
    | - $\Delta H$ - enthalpy change  
    | - $\Delta H_f$ - entropy formation  
    | - entropy cycle  |      |
|      | - hydrocarbon, $O_2 \rightarrow H_2O, CO_2$  
    | - chemical equation  
    | - $\Delta H_c$ releases energy, exothermic  
    | - $\Delta H_f$ - stores energy, endothermic  
    | - showing reactant, product, intermediates, steps  |      |
|      | - $C_4H_{10}(g) + O_2 \rightarrow CO_2 + H_2O$  
    | - simplified to 1 mol $C_4H_{10}$  
    | - flipping signs of $\Delta H$ |
# NDA and Hess’ Law Students’ Work

<table>
<thead>
<tr>
<th>Name</th>
<th>Describe</th>
<th>Act</th>
</tr>
</thead>
</table>
| Name | · Reactants  
   · Products  
   · Elements  
   · Enthalpy changes of formation  
   · Combustion of Butane | Entropy of combustion to form 1 mole of a substance |
| Describe | · The reactants are C_6H_6 + 6.5O_2 which is then converted to 6CO_2 + 5H_2O  
   · The reactants are the basic compound used  
   · H_2O = products He = reactants | |
| Act | · Explore how to find the enthalpy change through the simple product versus the sum of the reactants enthalpy  
   · Combustion reaction with CO_2 are the arrows | |
# NDA and Hess’ Law Students’ Work

<table>
<thead>
<tr>
<th>Name</th>
<th>Describe</th>
<th>Act</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- (enthalpy change) reactions/chemical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- enthalpy cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- $\Delta H$: enthalpy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Describe</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- combustion reaction: 2 equations, produce $CO_2$ + $H_2O$</td>
</tr>
<tr>
<td></td>
<td>- enthalpy cycle: takes the elements and applies them to the equation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Act</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- equation shows how the production happens</td>
</tr>
</tbody>
</table>
NDA and Hess’ Law

- Students went to the board and wrote out their responses on the table projected onto the wipe board
- Students all had to write something
- Faster than me writing all of their comments
- Commented on everyone’s statements starting at the top
- Students are validated when they hear comments on their statements or additions to the conversation
- All students are part of the conversation
NDA and Hess’ Law Takeaways

- Students were doing the thinking
- Students had more agency
- Much more powerful and memorable for students
- Everyone was more active and risking
- Commented on everyone’s notes
- Students were more comfortable with Hess’ Law Cycle
- Students enjoyed it more than taking regular notes
- Gave students homework problems to attempt for homework
Make Note

After a lecture, film, reading, or discussion learners “make note” of ONE of the following:

- What is the most important point?
- What are you finding challenging, puzzling or difficult to understand?
- What question would you most like to discuss?
- What is something you found interesting?
Make Note

- Students answer one of the questions.
- Then discuss their response to the group.
- Then cards are collected and randomly passed around class.
- Students read card they received out loud.
- Use this as an exit ticket to gauge understanding and use to start next class.
Make Note Thinking Routine After Electrophilic Addition Mechanism Lesson

- Asked students to write down one thing they found interesting from the class on Electrophilic Addition Reaction Mechanisms
- As I taught the lesson, we also reviewed Addition Polymerization, Heterolytic Vs. Homolytic Reactions, Hybridization...
Make Note Thinking Routine After Electrophilic Addition Mechanism Lesson Student Samples

- Student focused on Electrophilic Substitution reaction and Addition Polymerization
- Always interesting what they find important
- Another way to assess understanding
Make Note Thinking Routine After Electrophilic Addition
Mechanism Lesson Student Samples

- Student accurately defined electrophile
- Student accurately drew addition, but doesn’t understand what an electrophile is from the example given
Make Note Thinking Routine After Electrophilic Addition Mechanism Lesson Student Samples

- Mechanism drawn well, but doesn’t understand that it is an electrophilic addition reaction
- Names drawn well
- Lots of good information
Make Note Takeaways

- Although the lesson was on Electrophilic Addition reactions, students found other concepts like Addition Polymerization and Electrophilic Substitution reactions also important/interesting.
- Really highlighted what they understood.
- Another useful exit ticket.
- Useful to do with +1 Routine.
+1 Routine

- Recall
- Add (+) 1
- Review
+1 Routine

- Modified routine
- Took Make Note Exit tickets and stapled them to a blank sheet of paper
- Students were then asked to add a detail, a new point, something that was missing or a connection
- Students were then given the sheets back


+1 Routine

Original

- Details added
- Heterolytic substitution
- Different colors of ink
- Students have another resource with input from others on important ideas
+1 Routine

Original

Benzene is not good for addition
Benzene is good w/ substitution

- Same student wrote heterolytic substitution
- Nice details like explanations and names
- Encourage students to write what they think, no judging
- Splitting pattern not correct for benzene, address later
Routine Takeaways

- Students think about what is most memorable
- Good for students to see what others write
- Good for students to help expand each other’s knowledge
- Collect notes at the end
- Can project scanned pdfs and discuss after students make notes
- Good to make corrections as a group
- Good for students to see what others value as important
- Good to think critically about what others write
- A colleague who is an English teacher uses this all the time.
- Great to use with regular notes as well
Summary

● Drawing Exit Tickets
  ○ Students use different parts of the brain and body to create memories of abstract concepts
  ○ Students like the validation of having their ideas submitted
  ○ Excellent way to review material from previous day

● Note-Taking Thinking Routines
  ○ Research shows that students learn better when they have agency over what they have learned
  ○ Students enjoying breaking down concepts and noting what they find important more than regular note-taking
  ○ Students benefit from being critical of what others write and add to it

● Always interesting what students find important
● Brings joy to see creativity from the students for me and for them
● Routines can be used for a wide variety of subjects and levels.
Bibliography

- Pathways to Understanding: Developing Students’ Memory & Note Taking Skills by Ron Ritchhart
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To complete a brief survey about and to generate your attendance, visit:


To Download Resources:

http://bit.ly/MargaretHoeger

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