Chapter 3

Mahesh Alur: Balancing Chemical Reactions

I have been a teacher for the past eleven years at the secondary level. For ten of those, I have taught in Chicago Public Schools. Currently, I teach IB Biology, Chemistry, and Exploring Computer Science at Amundsen High School in Chicago's Bowmanville neighborhood. Go Vikings! Prior to teaching, I earned my BS in Biochemistry from the University of California, Davis and my PhD in Molecular and Cancer Biology at Northwestern University. I currently live in Chicago's Edgewater neighbourhood with wife, son, and two cats. In my free time (ha!), I like to spend time with my family, watch TV, read, and think about running, For more information about me and the achievement of my students, please visit http://maheshalur.com.

Balancing Chemical Reactions – Guided Inquiry

Grade Level: Applicable to middle school and above

Content Area Topic: Chemistry

Content Area Standard(s):
MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Learning Objective(s):
Students will be able to balance chemical reactions.

Suggested Time Allotment:
45 minutes period with additional practice time.

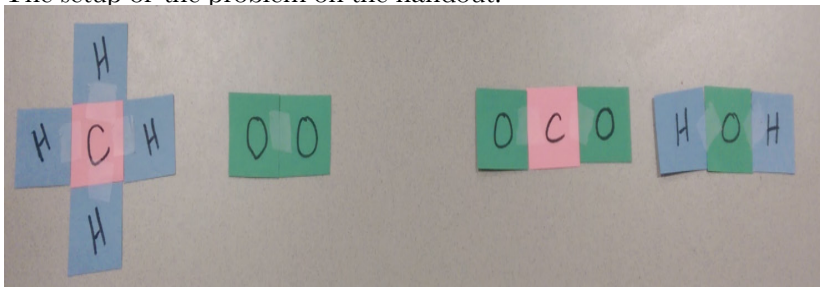
Sequence in Learning:
Students will have just completed an inquiry proving the law of conservation (using vinegar, baking soda, an Erlenmeyer flask, and a balloon). They also will have watched my instructional video about balancing chemical reactions on my YouTube channel. Students will rewatch the video after this activity to solidify their knowledge. On subsequent days, students should be practicing balancing through worksheets. This knowledge will be used to calculate stoichiometric values in chemical reactions.

Materials & Resources Needed:
- 3 colored pieces of paper per group/scissors/tape/markers.
- YouTube Instructional video (many sources are available):
- http://youtu.be/UBPTLEMW0vo?list=PLcrx4ZZBbr4n7mF7fGW-JPhZuWYTsS96R]

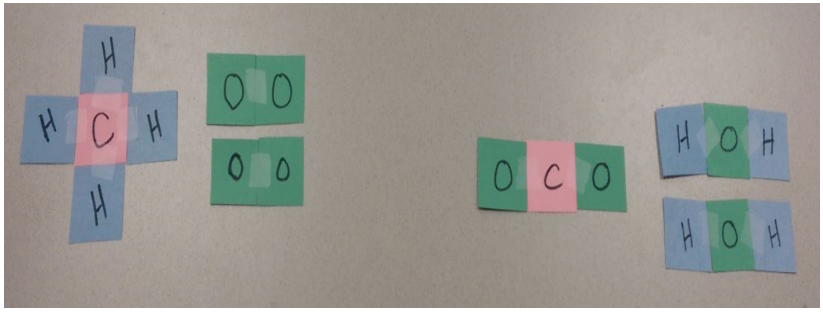
Lesson Activities & Sequence:
Students are sitting in academically heterogeneous groups or in homogeneous groups with occasional help from students who acquire the information more quickly. With heterogeneous grouping, higher achieving students can assist students who are struggling with the material. In this scenario, these higher achieving students' knowledge becomes questioned and/or solidified. I employ a flipped classroom strategy, so homogeneous groups can be supported by the teacher and by other students who have already completed balancing.

I use POGIL methodology (http://www.pogil.org). Groups consist of four to five students. Each student has a particular role that they conduct faithfully towards successful completion of the assignment. Please consult the "Related Resources/Ideas" section more information.
One group of materials is given per group so that they can cooperatively manipulate and share knowledge. Correct orientation of the atoms in a molecule is not required.

The setup of the problem on the handout:



The answer:



Different methods to balance equations are given verbally by the teacher (doing it visually, polyatomic groupings, using a table, checking after complete, odds vs evens, etc.) during practice. In addition, the YouTube video provides some of these strategies.

Proficiency:
By the end of the period, all students should have a general idea of how to balance chemical reactions. I check work by seeing how each student progresses through practice questions on the handout. I provide feedback and assistance where necessary. Proficiency on balancing cannot be demonstrated until more practice questions are attempted. More practice, for homework or in class the next day, will have to be used to solidify this skill. Individual completion of assignments ultimately indicates to the teacher if mastery knowledge is being reached. Ultimately, I provide a 5 balancing questions on a quiz along with a short answer question to assess student mastery.

Feedback

Teachers As Learners:
Color-coded manipulatives were useful. It was an advantage that students could write on them. The student roles were very descriptive and helpful. Student worksheet were clear and helped guide the activity and allowed students to work independently (to explore and make mistakes). The teacher acted as facilitator.

Elements of Pretty Good Practice:
- Teacher acted as a facilitator. He gave materials and clear instructions and stepped back.
- The use of colorful manipulatives allowed students to create models of the balancing reaction.
- The teacher provided appropriate positive reinforcement based on observed student behavior. He ensured that all students were participating by trying to pull in students into the conversation equitably. He also ensured that students were carrying out their roles faithfully.

Modifications and Adaptations:
- In what ways can the lesson be changed to accommodate my personal teaching and learning contexts and/or learners? (List the feedback from your colleagues)
- Extra sets of manipulatives could be provided. The author has used bead models in which he assembled each reactant and product in a plastic sealed bag in which each molecule had to be identified prior to balancing. The author has found that this lead to a "quick win" for students who might find balancing chemical reactions challenging.

Questions Arisen:
Can students have more access to the manipulatives individually?
What's the best way to group students?

Related Resources/Ideas:
- http://youtu.be/UBPTLEMW0vo
- Mahesh Alur's YouTube channel (http://bit.ly/AlurYouTube)
- Balancing Chemical Reactions POGIL Handout and POGIL role badges (found on the MSU STEM tab at http://maheshalur.com)
- POGIL Roles (PDF)