Tracing Matter and Energy in the High School Chemistry Classroom

Background

I conducted my capstone project on three classes of Honors Chemistry students during their second semester chemical bonding unit. The purpose of my research was to better address how matter and energy change during chemical reactions in the context of chemical bonding. I have observed some persistent misconceptions and misunderstandings involving concepts of matter and energy; in addition, students demonstrate difficulty applying these concepts to new phenomena or across science subject areas. The purpose of my action research was to incorporate new tools and instructional methods that will assist students in a deeper, more integrated comprehension of matter and energy.

Intervention

My Intervention consisted of adding the following learning target to our Bonding Unit: I am able to determine whether a reaction is endothermic or exothermic based on the bond energies of reactants and products. In terms of activities, all classes received more explicit instruction on energy involved in chemical bonding along with lab experiences and activities applying knowledge of endo- vs. exothermic reactions and bond energetics. More explicit lessons on tracing matter and energy during a chemical change involved using energy diagrams and explanations for how the conservation laws apply during different reaction types.

Research Questions

Primary Question

What are the effects of tracing matter and energy on student understanding of chemistry?

Secondary Questions

1. How does incorporating energy into a chemical bonding unit affect student understanding of energy in chemical reactions?
2. How does the use of tools that allow students to trace matter and energy changes affect their understanding of the laws of conservation of matter and energy?

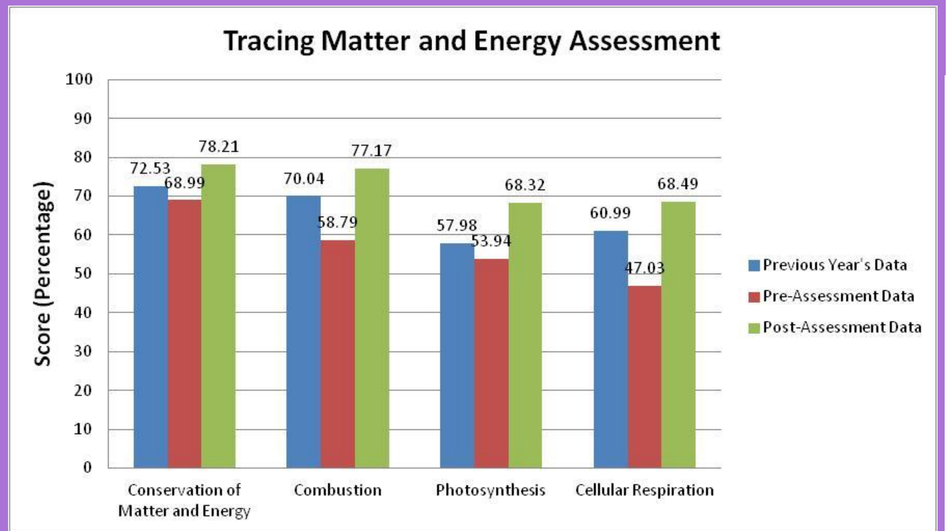
Data and Analysis

•Based on the Post-Assessment data, students showed consistent gains on all 4 categories, with higher scores on Conservation of Matter and Energy and Combustion (78% and 77%, respectively) than on Photosynthesis and Cellular Respiration (both with a 68% score).

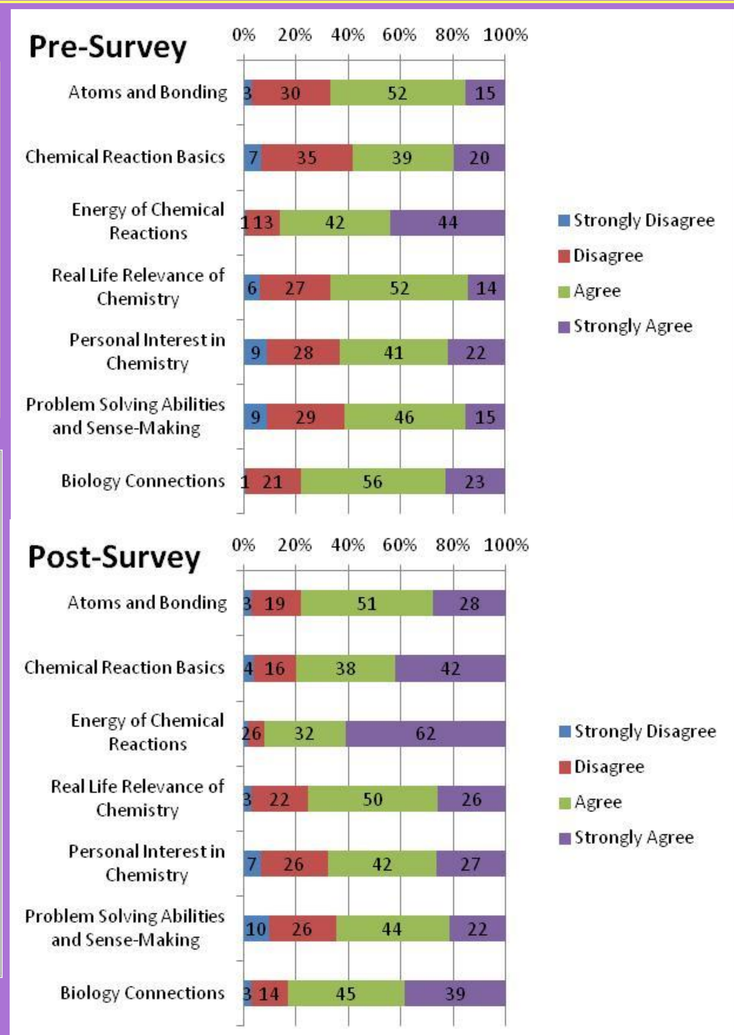
• The Post-Assessment mean score for the non-intervention group was 16.33 and the mean score for the intervention group was 18.02 out of a possible 24 points.

•Despite these apparent gains, a t-test was conducted. The p-score was .067643; based on this score the null hypothesis is accepted, so the resulting gains for the interventional group are not statistically significant.

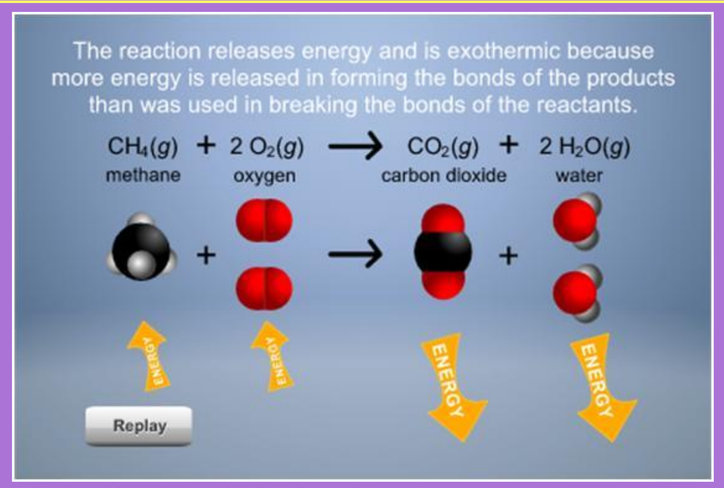
•In analyzing the survey data on student attitudes, in all 7 domains students become more positive--agreeable responses on average followed the intervention.



Average Scores of Comparison Group (n=47), Pre-Assessment (n=73) and Post-Assessment (n=74) Groups on 4 Categories of Assessment



Chemical Bonding Pre-Survey and Post-Survey (n=73), Student Attitudes on 7 Domains



American Chemical Society. (2018). Methane and Oxygen React.
http://www.middleschoolchemistry.com/multimedia/chapter6/lesson1
Permission is granted in advance to use animations and videos in the classroom or for non-commercial teacher professional development workshops.

Conclusion and Value

•Based on the results of the Tracing Matter and Energy Assessment, along with student confidence on the Chemistry Bonding Unit Survey and the evidence gained through interviewing and journaling student interactions, it is clear that students have advanced in their abilities to clearly explain and comprehend the difference between matter and energy.

•Based on the new additions to the chemical bonding unit, I am confident that students have a solid foundation on the importance of energy in chemical bonding based on the results of this research project. In addition, the tools used during the intervention have advanced student ability in understanding and explaining the conservation laws.

•While these Chemistry topics are abstract and complex, there are clearly effective resources and pedagogy that help students in their learning of the chemistry.

Dan Curran

DeForest Area High School, DeForest, WI