Using Disaster to Teach Science

An Event-Based Science® Activity Using Quantum Artificial Intelligence Chemistry Tutors

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Oil spills, forest fires, tornadoes, toxic leaks... there are incredible, dramatic events in the newspaper every day to help us teach science concepts. The challenge is finding creative ways to hold the interest and excitement of students beyond the sensationalism of these events. The NSTA-recommended Event-Based Science Project has developed short activities for chemistry that combine proven real-world science instruction with new cutting-edge artificial intelligence tutoring software to help students get the most from their study time.

Using one of Quantum's Artificial Intelligence Tutors, "Balancing Chemical Equations," I will show you how to relate real-world concepts back to important problem-solving skills so you can see how this teaching approach can be applied to improve other critical science skills such as ratio and proportion, oxidation numbers, stoichiometry and more.

Balancing chemical equations is at the heart of our understanding of conservation of mass and is a cornerstone of many other important chemistry topics such as stoichiometry. It can be difficult for teachers to get students not only to understand how to balance equations successfully, but to understand the true meaning and value of performing the task. Students often have the impression that equations are intimidating and, oftentimes, dull and boring.

Then there is the student who is successful sometimes, but not always. This student's work usually shows evidence of multiple tries at balancing the equation before discovering a satisfactory solution. Though this student is clearly working hard to "figure out the answer," their approach is usually through guessing and trial-and-error. When the problem is not solved, the student has no real understanding of why it failed. The sad truth is, no matter how many examples these students attempt, their success rate hardly improves at all because they are learning nothing new from their experiences.

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Event-Based Science® Captures the Interest of the Student

Developed by Dr. Russell G. Wright, Event-Based Science (EBS) is funded by the National Science Foundation and NASA, and recommended by the U.S. Department of Education. EBS begins with a real event that is in some way related to a science concept. It uses an article about the event that actually appeared in the news media. By carefully selecting interesting news articles, EBS is able to convince students that the science topic is something they would want to learn more about. It is a technique that teachers have used before, but with EBS, it is exceptionally well done. EBS modules target middle school science and high school chemistry.

The model used by EBS for engaging science activities is called the Total Engagement Learning System (TELS). According to TELS, the secret to keeping students engaged is an authentic activity set in a real-world context. An authentic activity works to engage students for three reasons – context, purpose and differentiation.

- **Context:** A real-world context makes learning meaningful. (A newspaper article or other authentic report establishes that context.)
- **Purpose:** An authentic activity gives students a reason to learn related science concepts and problem-solving skills.
- **Differentiation:** Authentic activities demonstrate how people with different skills, interests and jobs can all use and apply the things they are learning in school. In the classroom, this means role playing, and role playing means natural differentiation.

Quantum Tutors Keep the Student Engaged and Teach Key Learning Concepts

Once the students have a real-world event as a point of reference, the Quantum artificial intelligence (AI) Tutors are used to guide the students through the steps of balancing the equations based on the actual event.

Just like a human tutor, Quantum's tutoring software gives personalized hints, guidance and feedback based on the student's own work and subject knowledge. The Quantum Tutors are ideal for use with EBS for several reasons.

The Tutors:

- Accept any problem that students need to study, so they can be used for any event-based exercise.
- Allow students to enter their own work. Similar to a human tutor, Quantum Tutors interpret the work and provide coaching and feedback based on the student's unique responses, adjusting guidance to fit an individual's performance level.
- Include an evolving menu of questions that change based on how the student is approaching the problem. By teaching the student to ask better questions, comprehension improves and the student continues to be engaged in the exercise through their genuine curiosity to learn.
- Allow anytime/anywhere access through the Internet, making the Quantum Tutors ideal for students working at home on assignments where a teacher is not readily available.
- Provide a session transcript of the student's learning activity which can be e-mailed to the teacher for further review and discussion.

Example of natural gas pipeline fire.

A Real-Life Example Using a Natural-Gas Pipeline Explosion

The news event that this activity uses is a natural-gas pipeline explosion that occurred when lightning struck a tree on a golf course, causing a minute leak in the burried gas pipeline. The escaping gas ignited, sending flames 30 feet into the atmosphere.

It is easy to see how such an event sparks the interest of students and can be used to motivate them to learn more. The chemical equation for this combustion reaction is weaved into a broader activity on the concept of chemical equations and the necessity of having them balanced. The activity is available free to download from the Event-Based Science web site at: **http://www.mcps.k12.md.us/departments/eventscience/OtherActivities/EBS.qs1sa.html**

The exercise is provided in detail on the next page and ready to use in the classroom. It contains a link to the actual newspaper article from the Pine Journal (MN) and a link to an additional background essay on combustion that was developed by the EBS Project.

In the activity, students assume the role of federal inspectors and are instructed to write to the Office of Pipeline Safety at the U. S. Department of Transportation with their findings. A photograph of a pipeline fire captures students' imaginations and excites them to learn more about the chemistry involved. Students at all levels are captivated by the sheer magnitude of the explosion, making the activity engaging and appropriate for any class where chemical equations are taught. The class time involved can vary from a single day to three days depending upon the level of your students and how deeply you wish to penetrate the topic. It is even appropriate for biology classes since the combustion equations used as an introduction are very similar to those encountered in introductory biology.

Science Activity: Combustion

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Purpose
To use the Quantum Equation Balancing Tutor as a tool to balance several combustion-reaction equations.

Materials
- Newspaper Article about Pipeline Fire
- Equation Balancing Tutor
- 3" x 5" card

Background
Last Wednesday, when lightening struck a tree at the Cloquet Country Club (Cloquet, Minnesota) the result was a fire in a natural-gas pipeline. The 140 pounds per square inch of pressure in that pipeline caused flames to reach a height of 30 feet.

Just how could lightening cause a fire in a pipeline buried two to four feet underground? Federal inspectors are investigating and they need your help to complete their work.

As a chemist, your specialty is chemical reactions. Because of your expertise, you have been asked by the inspectors to help them with the chemistry portion of their final report. They want you to give them a balanced equation for the combustion of natural gas and for the combustion of at least two other fossil fuels.

Procedure
Natural gas consists mainly of methane – a simple compound that has a carbon atom surrounded by four hydrogen atoms. Methane is a highly flammable odorless gas. When it burns, it leaves behind no ash and very little air pollution.

The formula for methane: CH_4

Combustion of methane involves its reaction with oxygen in the air. Heat, light, carbon dioxide and water vapor are released.

That reaction equation is written: $CH_4 + O_2 \rightarrow CO_2 + H_2O$

Use the Equation-Balancing Tutor as you try to balance this equation. You can receive a **Free 15-Day Trial to the Quantum Tutors at: www.sciencekit.com/elearning**.

The inspectors would also like to compare the combustion of methane with the combustion of several other fuels. Use the Equation-Balancing Tutor to balance the following equations:

Methanol $CH_3OH + O_2 \rightarrow CO_2 + H_2O$
Gasoline $C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$
Hydrogen $H_2 + O_2 \rightarrow H_2O$

Conclusion
Address and mail a 3" x 5" card to the Federal Inspectors who investigated the Colquet-pipeline explosion. Their address is:

Office of Pipeline Safety
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590
Attention: Colquet Pipeline Inspectors

Be sure to place your return address in the upper left-hand corner.
Now write the four balanced equations on the other side of the 3" x 5" card and label each reaction with the name of the substance that is burning. Use your best handwriting.

Results of the Science Activity

I have tried this activity and it is truly outstanding. My students loved it, and the artificial intelligence Tutor both amazed them and set them on the right path for success. I observed that it had a significantly helpful impact on my students' proficiency and understanding. In the same way, you can expect your students to develop a true understanding of why equations need to be balanced and also find a simple and workable approach to the balancing process. I found the synergy of the combination of EBS with educational technology powerful and compelling.

To try this exercise with your students, simply access the Event-Based Science activity from the web at **www.eventbasedscience.com** and obtain an annual subscription, or Free 15-day Trial, to the Quantum Equation Balancing Tutor at: **www.sciencekit.com/elearning**.

ABOUT THE AUTHOR

Mr. Dale A. Holder, Co-Founder and Chief Academic Officer, Quantum Simulations, Inc., has more than 35 years teaching experience in chemistry and mathematics at Russell County Schools in Kentucky. He has received several teaching awards including Kentucky's 2004 Wal-Mart Teacher of the Year, Most Outstanding Secondary Science Teacher in Kentucky for 1999 and 13 additional Outstanding Teacher Awards. Mr. Holder can be reached at holder@quantumsimulations.com.