Vernier Technology Award

Abstract

I, Sharla Dowding, am a high school biology and chemistry teacher with 19 years experience. As a science teacher, my goals are to challenge the brightest students, motivate the middle to excel, and accelerate those who may be behind. Inquiry is an effective way to develop content understanding because students develop understanding of processes at their own cognitive levels. Using probe-ware to approach inquiry also helps to develop a number of problem-solving and quantitative reasoning skills.

Beer's Law is a set of labs that I use in chemistry class. Students start by investigating concentration of a solution with a cook-book Beer's Law lab. I modify one from the Vernier website and we use the Spectro-Vis plus probe with our computers and Logger-Pro software. Once students see how this works with a known compound, they investigate the concentration of food coloring in fruit loops. At this point they need to determine how to make a 10-mL stock solution of food dye in order to prepare a serial dilution curve that serves as their known-concentration samples. After participating in the standard Beer's Law labs, students apply Beer's Law to a situation of their choice. Some students look at the concentration of Kool-aid solutions, others apply it to the amount of sugar in soda. In one unique inquiry investigation, a young lady applied Beer's Law to determining the amount of ozone in the air.

Feel free to visit one of my websites for more information about what occurs in my classroom.

http://weston.wy.schoolwebpages.com/education/dept/dept.php?sectionid=30&

http://w3.tribcsp.com/~sharla/

Program Description

As a science teacher, my goals are to challenge the brightest students, motivate the middle to excel, and accelerate those who may be behind. My philosophy is to provide students skills and knowledge that will develop critically thinking, life-long learners who know and understand science and who will be able to reflect on the implications of science in society. Inquiry fits into my goals by helping students to become active learners who can think creatively, communicate, and work in teams. Inquiry is an effective way to develop content understanding because students develop understanding of processes at their own cognitive levels. Inquiry also provides a way to scaffold upon what students already know and then extend their thinking with new information.

Beyond content and skills I want students to learn to use time constructively in group settings to achieve common goals and I want students to receive high-quality instruction, filled with intellectual richness and challenging tasks. Throughout the year I want to shift the balance of who's in charge from me to them. When my students reach this point, I become more a facilitator and less the classroom leader. By creating a learning environment where my students want to learn, students get excited about doing science, and own their science experience. In addition, using probe-ware to approach inquiry also helps to develop a number of problem-solving and quantitative reasoning skills that include: applying mathematical concepts, ability to manipulate and calculate, possess number sense and estimation skills including understanding small and large numbers, employ proportional reasoning including working with ratios and percentages, and calculate basic descriptive statistics.

No technology, no matter how amazing, can by itself ignite a shift from good to great. My science department is small, consisting of only three people. Working collaboratively we share requirements about student OneNote (electronic notebook) organization, inquiry projects, and classroom policies. In August 2008 we became a one-to-one school. Each student is issued a laptop to use as a tool. However, technology cannot create a culture of discipline nor supplant the need for deep understanding of concepts. I use technology as an accelerator for student understanding, not a creator of it. Technology itself is not a primary cause of meeting AYP.

Words make it hard to describe the variety of instructional strategies I utilize. Among my repertoire of pedagogical content knowledge is implementation of the 5-E model (engagement, exploration, explanation, elaboration, evaluation) using audio-visuals, demonstrations, discussion groups, lectures, practice-by-doing, reading, providing adequate time for sense-making, inquiry questioning, and having students teach each other. Making learning goals clear to students, assessing for prior conceptual understanding, providing background information, providing opportunities to address misconceptions, and developing collaborative classroom climates all contribute toward development of inquiry-based teaching. I use Page Keeley's formative assessment probes at the beginning of each unit. Experimental design processes allow for independent student experimentation. In identifying questions for testing, students design experiments and collect data with probe-ware which leads to peer-review and reflection. Utilizing modeling-instruction and white-board discussions after every data-collection opportunity, student passivity, and the persistence of naïve beliefs about the physical world are addressed daily. Concept mapping and asking probing questions are means to help students consider concepts critically. By scaffolding instruction, students know what is expected before, during and after each learning experience. Utilizing one-to-one capacities and engagement in calibrated-peer reviewing (CPRs), my students engage in scientific discussions that are rarely seen in high school classrooms. One young lady enthusiastically remarked, "My science teacher really makes me think!"

Program Description

My team is committed to improving science instruction through the implementation of the National Science Education Standards and research-based methods. My science team cooperates on alignment of district curriculum to state standards. Use of common assessments and team planning of student projects among the science classes facilitate students knowing what is expected from year to year in science.

Even before it became popular, I was using an Understanding-by-Design model to plan learning experiences and instruction. By making science accessible, making thinking visible, helping students learn from each other and promoting metacognition my curriculum units are scaffolded for knowledge integration. The foundation of our inquiry-based curriculum identifies desired results in each context then allows students multiple avenues to display their knowledge. This is especially evident in my science classes. At the beginning of each course I combine a guided inquiry approach with a conscience development of student process skills. This directly leads to a student-centered curriculum. My reliance on performance driven assessments rather than normative assessments gives me flexibility to assess students as individuals. In the selection of individual research projects, I advise students to use probes they may not have considered in their data collection in order to deepen their understanding of complex concepts such as using pressure sensors to investigate the gas laws and inverse relationships.

As chair of this progressive science department, I implemented graphing calculators and CBL's in 1997. Regular integration of Vernier probes and LoggerPro software, along with TI-Interactive and Navigator equipment quickly followed. The sustainability of this department rests on the coordination and cooperation of the teachers utilizing instructionally supportive technology. My group of teachers has worked together for several years building Science Olympiad teams, study groups, and hosting Science Fairs. This degree of commitment has given us a reputation in the community of striving for excellence in projects we undertake. We have built community support for a variety of projects from the hospital to the refinery; we strive to extend our presence with technology mentors from the two labs in our community.

Since 1998 approximately 300 students have participated in the WY Science Olympiad, over 75 in the Jr. Engineering Technological Society (JETS) competitions, 250 in the Chemistry Olympiad (16 state finalists), 72 in science bowls, 350 in other academic science competitions at local colleges, 2 finalists in the NASA Dream Challenge, 5 science symposium finalist, and 28 students have gone to summer science camps. Our spring-2011 average ACT science score was 20.2. I am particularly proud of this average score as <u>all</u> of our juniors take the ACT test, including non-college bound and special education students on IEPs.

Milestones in my tenure at NHS include moving into our new facility in 2002, being the first department to independently develop a school wireless network, and to be the first teachers to individually create school-based websites and use Smart-Boards and graphing calculators. Becoming the host community for the regional six-county science fair annually engages over 40 community volunteers as judges and mentors.

Reflective teaching means developing an attitude of inquiry toward one's own practice. I annually participate in school improvement conferences, state (WSTA) and regional (NSTA) science conferences. We are proud that we have made it a priority to travel, as a k-12 science staff, to a number of content-specific opportunities. A defining transition in professional development for this department was selection, in 2004, to participate in a science leadership academy developed by McREL. This two-year commitment helped us to develop a vision for science instruction district-wide and our implementation of "what research says" to improve the rigor and relevance of science for our students. In 2008, as a department, we participated in a

WYTRiAD conceptual-change modeling (CCM) institute. WyTRiAD is a three-year process where teachers, administrators and facilitators work as partners to improve what goes on in the classroom and in the school. Over several months we observed teachers in Wyoming schools and discussed experiences, advantages and limitations of implementing CCMs. WyTRiAD was featured in the NSTA monograph Exemplary Science: Best Practices in Professional Development. Training teachers for a one-to-one laptop initiative, presently being implemented, began in 2008, and continues today. In addition, I have participated in NSTA web-seminars and partake in summer courses and on-line classes through various universities, such as curriculum design through Montana State University, educational statistics through the University of Wyoming, and models of technology use through Colorado State University. Our most current undertaking was participating in a Quantitative Reasoning & STEM initiative partnership through the University of Wyoming.

No technology can instill the discipline to confront brutal facts of reality, nor can it instill unwavering commitment. Through a desire to improve practices, my science department challenges assumptions, while fostering enthusiasm. Our hallmark at implementing reform-based strategies, collegiality, and leadership is our proactive whole-department cohesiveness to empowering changes. I have tried to avoid technology fads and bandwagons, but instead respond with thoughtfulness and creativity in the application of carefully selected technologies such as Vernier sensors and probes, use of Web-Assign, and OneNote, to mention but a few.

I have received several innovative-project grants which have supplemented my science budget and used to purchase technologies such as a Mini-GC and a thermal imaging camera. My budget has also been supplemented by teaching awards from the PAEMST, the National Association of Biology Teachers and the American Chemical Society.

Description of Lab Activity

a. Beer's Law is a set of labs that I use in chemistry class. Students start by investigating concentration of a solution with a cook-book Beer's Law lab. I modify one from the Vernier website and we use the Spectro-Vis plus probe with our computers and Logger-Pro software. Once students see how this works with a known compound, they investigate the concentration of food coloring in fruit loops. At this point they need to determine how to make a 10-mL stock solution of food dye in order to prepare a serial dilution curve that serves as their known-concentration samples. (More than one student has joked about making cereal-dilutions☺.) A student's copy of this set of activities is attached.

b. After participating in the standard Beer's Law labs, students apply Beer's Law to a situation of their choice. Some students look at the concentration of Kool-aid solutions, others apply it to the amount of sugar in soda. In one unique inquiry investigation, a young lady applied Beer's Law to determining the amount of ozone in the air. This project led to a third-place finish in the chemistry division at our state science fair. This fall, on young man designed an experiment to determine the effect of solution concentration on the absorbance of light in an oxidation-reduction reaction. This was a modification of the blue-bottle demonstration; however he used resazurin, calling it the pink-panther oxidation reaction. Excerpts from these students projects are also attached.

Technology is integrated into content from delivery to assessment. Through inquiry, every step has a technology component. Instead of formulas delivered by lectures, students conduct experiments, collect data, and graph results to derive formulas to represent their understanding. A specific example from biology: Students, using the Spectro-Vis and laptops, designed an experiment to investigated bioluminescence. Students have designed experiment to test the effects of variables such as temperature, concentration, & color on luminescence reactions. Scientific habits-of-mind is my overarching principle of science content. I want students to think inquisitively about the natural world. Having students use technology when gathering data for projects shows commitment of teaching real-world applications.

Since 2002, over 400 NHS students have participated in the regional science fair, with over 175 students qualifying for the Wyoming State Science Fair, with numerous category awards being won. Former student feedback indicates several graduates are currently in a variety of science-related careers and professional schools. Yearly letters and emails are received, thanking me for preparing them through a rigorous and relevant curriculum. NHS graduates are required to meet standards in three science courses: physical science, environmental science and biology. Additionally six other science courses are offered. Of the graduating class of 2012, 34% will have taken 4+ science courses in high school. In the graduating class of 2012, I will have taught 13% of the class throughout four years, in the sequence: health, biology, chemistry, advanced chemistry, meaning these students will have taken six science courses (some more) in high school. I think this speaks volumes about the rigor, relevance, and impact of science at my school.