University of Northern Iowa

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Lyn L Countryman

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Rigorous, Relevant, Involved Inquiry – The Best Science
Discussions concerning high school reform center around two concepts rigor & relevance. At least twelve states (Olson, 2005) have introduced “rigor” bills requiring increased coursework, increased participation in a college prep course of study in high school, and/or requiring dual enrollment with the state footing the bill. Other states are increasing the requirements for graduation to four years of math and science. If increasing requirements were the solution to rigor, it would seem that those advocating such a simplistic answer would see acquisition of more information as the goal of science education. With information tripling every four to five years, one wonders how much more information students could memorize to keep up? Instead, this science teacher would argue that the real RIGOR comes not from increasing requirements, or mandating AP curriculum but it comes from what we ask of our students in each science classroom and the role we choose to play science education. We need to expect students to become active thinkers, to construct their own knowledge, and to pose questions. If we succeed in this then we will have created science classrooms that are rigorous and relevant, where students become the voices and forces of action in their world.

Expecting students to think in our classrooms requires us not be the conveyor of knowledge, but instead, to become the intellectual coach/facilitator in the classroom. Instead of telling students what they will understand about science before they do an activity we have to structure the activity so that answers are not given, but instead questions are asked so that the students can discover the “answers”. This is the initial stage of a teaching strategy called the learning cycle developed by Robert Karplus in the 1960’s. It is an inquiry-based constructivist strategy involving three phases: exploration, concept development, and application (Figure 1.) In exploration activities students observe relationships, identify variables and develop tentative explanations of phenomena. In the second phase, concept introduction, the teacher in a
culminating discussion, usually conducts concept development, after the activity. It is where teachers elicit observations from the students and attach the concept name to the observations and elaborate upon the concept. In the application phase students test the generalizations they have constructed in new situations. It is in this application phase where vital connections can be made from the science content to real-world applications. Deep learning revolves around high levels of cognitive knowledge applied to situations and problems that people address in the real world (Daggett, 2005). Daggett reaffirms that secondary schools can no longer teach facts, but must teach students how to think. The power of the learning cycle strategy is how it gets students to think. The teacher has a responsibility to provide probing questions, to keep students focused on the activity and challenge students to think. Instead of being the sage on the stage, teachers need to become the intellectual coaches challenging students throughout the learning cycle to think deeply about the concept and relate it to their world. The active engagement inherent in the learning cycle is imperative, since nearly 40% of high school students are just going through the motions instead of playing an active role of learning in the classroom (Steinberg, Brown & Dornbush, 1996). When students are actively engaged in inquiry they make higher achievement gains (Johnson & Lawson, 1997; Unruh, Countryman & Cooney, 1992) and develop increased scientific thinking (Shepherdson, 1997; Thacker, Kim & Trefz, 1994.)

I moved to this type of teaching early in my career as a teacher. I have seen its success not only in student achievement but also in increased classroom participation and engagement by all learners. Initially, though, when one transitions from a traditional didactic and verification laboratory classroom to the constructivist approach found in the learning cycle, one will meet resistance from some students. Students who have been successful memorizing in a didactic
classroom will rebel against having to find their own answers. You will hear again and again, “Just tell us what we need to know.” If you persevere and keep challenging students to do the thinking students will reap the rewards. Students will find if they “invent” the science concept they will remember it.

A final benefit of this strategy is that when students are deeply and actively engaged in their learning they also begin to find their voice in the world. They realize that they own their knowledge and that understanding gives them the strength to speak out and base their conclusions on the observations they have made. This is what separates science from other worldview. Science bases its conclusions on the facts, and data that are collected. When students begin to apply their knowledge to real-world situations in the application phase they can see that their knowledge can have an impact. They begin to acknowledge their voice. Acknowledging and then using their voice (ability to act) enables them to become visible (participatory) members of the world. A natural consequence of this teaching strategy and the subsequent student empowerment has allowed me to structure additional learning experiences where students have the opportunity to acquire the skills to become active and responsible citizens in our democracy.

One of the logical outgrowths of this type of teaching in our school has been our connection to ASCD’s First Amendment Schools Project. I see this connection as an extension of quality inquiry science in the classroom. When kids begin to think, they begin to dream, they begin to act. It is our jobs as educators to help them act responsibly and respectfully. In science it is my hope that they begin to act on what they have observed and learned instead of reacting based upon their beliefs and opinions. I have just begun to increase the ways I incorporate the principles of the First Amendment into my biology classroom to encourage even more students’
voices and action in the world. I look to the developed Core Civic Habits (ASCD, 2006) to work with my biology students to “show concern for others and act with courage and compassion” (Habits of the Heart) as they begin to take action on the environmental issues that plague our world. I will encourage them to understand that “how we debate, not only what we debate, is critical” (Habits of Voice.) Through investigations into tough issues such as stem cell research and genetic modifications they can “appreciate both the complexity and ambiguity” (Habits of the Mind) and “agree and disagree honestly and respectively” (Habits of the Voice.) Throughout their biology work I will help them “integrate their passions and deepest values into their work and work always with integrity and persistence toward the common good” (Habits of Work.) The principles of the First Amendment blend seamlessly into a rigorous science curriculum where students are doing the thinking and the acting. Inquiry instruction has been an effective tool in science education since the post-Sputnik reforms of the 1960’s. It remains the preeminent method of teaching science content understanding and the essential style for the high school reform efforts calling for rigor and relevance. It also offers unparalleled opportunities to utilize the student voice encouraged in this method to enable students to become VISIBLE (acting, caring contributors to the common good) in our world.
Figure 1: The Learning Cycle
References


Olson, L. (2005, March 2). States take steps to put more rigor into high schools—College, work readiness are focus of governors. Education Week, vol. 24, i.25, 1-22.


