

The authors suggest that the nature and format of the questions on the EOC standardized test are a concern. The present test focuses mainly on objective knowledge, and there are better techniques than the use of multiple choice questions to test the skills and concepts learned during inquiry. The North Carolina Department of Public Instruction advocates an inquiry approach, yet the present style of EOC standardized test may not be appropriate for measuring the outcomes associated with such.

Reference

Tretter, T. R., & Jones, M. G. (2003). Relationships between inquiry-based teaching and physical science standardized scores. *School Science and Mathematics, 103*(7), 345-350.

How Jeff Gordon and NASCAR Helped to Develop a High School Science Curriculum and Educate Future Teachers

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Abstract

The focus of this article is the development of future science teachers. A research project, involving Cornell University, the Cornell Center for Materials Research, and NASCAR Champion Jeff Gordon is described. All research was conducted in association with faculty and staff at Cornell University and resulted in the development of a science education lesson that became part of the SCT BOCES New Visions Education Program.

The Challenge

Imagine the following scenario. You are the teacher in a special program that recruits high school seniors who want to be teachers. You have been told by regional educational administrators that there is a definite need for science teachers at all levels. Your students have already taken most of the available science courses available to them, so they need something different to study. They need something challenging. Keep in mind that these future teachers will need motivating science activities to take into the regular classrooms when they do their student teaching rotations. Your challenge is to create a hands-on science curriculum that can create a love of science. This is your challenge.

This article recounts such a challenge. It is a story that involves a teacher training program, a major research institution, and a world champion NASCAR driver. More importantly, this is a story about building future science teachers. Here is that story.

Defining the New Visions Mission

The SCT BOCES (Schuyler-Chemung-Tioga tri-county area in New York: Board of Cooperative Educational Services) New Visions Education Program is designed to attract the best and brightest high school seniors and prepare them for careers in education. In schools where integrated curriculums are the norm, science education can be used to build critical thinking skills with all students. In New York State, the Department of Education has mandated that all K-12 science curriculums be aligned with the learning standards in Math, Science, and Technology. Since the SCT BOCES New Visions program is designed around the philosophy of technical education, students also build teaching skills under the heading of Career Development Occupational Standards. The mission of the New Visions Education program is simple: Educating our best with the mission to educate others.

Building Future Science Teachers

In this era of advanced technology, preparing future science teachers requires a component that looks at the real-life application of science content. Gone are the days where the science teacher lectures for the full period and then assigns the appropriate chapter on which a test will be constructed. Students in the New Visions program come into the field with a solid background of both math and science. The challenge for the New Visions student is to use this acquired knowledge to construct hands-on classroom activities that excite students about science. Knowing about various aspects of any area of science or math is crucial but, for prospective teachers, it is the delivery of this information that is crucial. Gone are the days where the science test is the only way to evaluate student performance. This is true especially for students who plan to enter the field of science education. It is the interaction between student and teacher that defines successful teaching. More specifically, for the prospective teacher, it goes well beyond the acquiring of knowledge. It becomes a challenge to make science meaningful and relevant to both the student and, more importantly, the teacher.

Enter Cornell University and the RET Experience

Cornell University and the Cornell Center for Materials Research (CCMR) understand how important it is for teachers to expand their knowledge through self-directed project research. The Research Experience for Teachers (RET) program is designed for such a purpose. The RET program is funded by Cornell University and the National Science Foundation. Teachers spend up to 6 weeks at the Center for Materials Research conducting research on a project that they have designed.

The Cornell Center for Materials research is headed by Dr Frank DiSalvo. Dr Helene Sember is the Associate Director and Nevjinder Singhota is the Director of

Educational Programs and the person who oversees the RET program participants. The Cornell Center links teachers with Cornell University professors and offers unlimited access to the research facilities on campus. The NASCAR/Tribology (the science of interacting metals) project came under the review of Dr Brad Anton, Professor of Chemical and Biomolecular Engineering. This connection was especially beneficial because Dr Anton brought road racing experience to the table. An avid road racer, Anton has driven many times at Watkins Glen International. This constant interaction with Cornell faculty and staff lead to the opportunity to develop hands-on technology skills leading to the end result of a science curriculum. Designing a science curriculum to supplement the New Visions Education curriculum that was already in place kept the research project focused throughout the summer of 2002.

The NASCAR/RET Project Proposal

During the summer of 2001, a series of contacts developed with Hendrick Motor Sports. Hendrick Motor Sports is the organization that fields the #24 car driven by World Champion Jeff Gordon. Through the efforts of public relations representative Jon Edwards, crew chief Robbie Gordon agreed to discuss a research proposal where an analysis of Gordon's brake pads and brake rotors would take place at Cornell University. The meeting took place at Watkins Glen International Raceway and an agreement was made to provide brake pads and brake rotors for analysis. This RET project proposal would seek to understand how metals interact on a NASACAR racer when the brakes on the driver's car reach a temperature of over 1600°F. At Watkins Glen International, brakes will undergo in excess of 250 heat cycles during a race. The amount of heat energy that is produced during a race is the key to analyzing how particles transfer from the brake pad to the brake rotor.

The RET Research Focus

The RET project was called the NASCAR/Tribology Project. As rotors and pads arrived from the #24 car, they were sent to Cornell University, where the analysis process would begin. Under the supervision of John Sinnott, supervisor of the CCMR materials facility, rotors and pads were sectioned off into a number of sizes and made ready for microscope analysis. John Hunt, supervisor of the CCMR light microscope and the scanning electron microscope labs, offered guidance on what could be learned by using microscopy to analyze metal samples under high magnification. As the summer progressed, the research project was expanded to include the hardness testing and the surface analysis of Jeff Gordon's rotor samples.

There was even a late entry to the project, as cryogenics became an issue. Cryogenics is the study of extremely low temperatures, and in this project involved the process of hardening metals by subjecting samples to extremely cold

temperatures. It is a controversial subject, and many involved with the project wondered what effect the process would have on race car rotors. Cryogenics was of special interest to the #24 team, including Rich Hubbs, the team's coordinator of brake pad/rotor setup.

The RET Project Research Results

At the end of the 2002 summer, in addition to building skills in the area of microscopy, surface area analysis, and hardness testing, a number of discoveries were presented to members of the Cornell University faculty and those who composed the RET program staff at the Cornell Center for Materials Research.

- Through light microscope analysis and surface area testing, it was discovered that the brake rotors used at the NASCAR race at Watkins Glen International had suffered a great deal of surface fade compared with the brake rotors used in the California race. In the case of the rotors used in California, microscopy analysis and surface area analysis revealed less surface fade under similar race conditions. In both cases, rotors reached a temperature of 1600°F throughout the race.
- Using a Rockwell Hardness Tester, it was learned that the process of cryogenics improved the cast iron surface structure of a racecar brake rotor. This was a surprise to many members in the presentation audience, who questioned how cryogenics would change a cast iron rotor.
- Using a profilometer (a surface area detector), it was learned that the rotors used at the NASCAR race at Watkins Glen suffered much more surface damage than the rotors used in the California race. This was the evidence, in light of the fact that both products underwent similar race conditions (i.e., heat temperatures, heat cycles, number of laps, etc.).

The main cause of rotor failure is the intense heat that builds up during the course of a NASCAR race. The challenge for the engineering staff is therefore simple: How can air be used to lower the temperature of a NASCAR brake system during competition?

Writing a NASCAR/Tribology Curriculum

Research from the 2002 RET experience went directly into the New Visions curriculum under the heading of science education. With the help of a SCT BOCES mini-grant, all New Visions students were provided with a Radio Shack hand-held microscope for use in class. The microscopes have a magnification power of 30X and are battery operated. To begin the unit on science education, students were provided with a review of the research that resulted from the NASCAR/Tribology

project. Students then had an opportunity to use a microscope to examine the surface areas of a variety of brake rotors used by NASCAR champion Jeff Gordon, and this piqued students' interest. One benefit from the program was that some of the rotor fragments came from a race at nearby Watkins Glen International Raceway, only 30 miles away from class.

The NASCAR/Tribology curriculum was also used by the New Visions Engineering students who made a field trip to Cornell University to visit the microscopy lab and the materials preparation department. Students even visited the SEM (scanning electron microscope) lab where they examined one of Jeff Gordon's rotor fragments. The visit was covered by the local media and featured on the front page of the *Corning Leader* in Corning, New York. The publicity from this project has stirred a great deal of interest from other teachers in the area. These rotor fragments have been stored in the New Visions classroom and have been used by entering New Visions students. Students are constantly amazed that they are examining a piece of Jeff Gordon's car. That's the exciting part of the experience and one that motivates these students to teach science through the local community.

Aftermath

Research reports from the RET NASCAR/Tribology project were delivered to Jeff Gordon and the #24 team. Research results and findings were also burned into a CD and sent to the National Science Foundation. The NSF report included curriculum activities that have been integrated into the New Visions Education Program. As a result of the report, other NASCAR teams have shown interest in becoming part of the project. Since the project, other discoveries and revelations have been made concerning the physics of tribology. The bottom line to the project is that, as a result of the summer of 2002, the students of the SCT BOCES New Visions program are learning how microscopy can unlock the secrets of a world not visible to the human eye. Now, the mission of these students is to teach and inspire other students interested in science.

An Update

Since the development of this RET/Cornell University curriculum, students have had an opportunity to take many of the lessons that have been developed and to try them out in regular classrooms in the Elmira, New York area. The results have been spectacular. Since the implementation of this curriculum, the New Visions program has been awarded grants from the SCT BOCES Teacher Center and the Twin Tier Coalition for learning. Monies from these grants were used to purchase more science equipment for use during student teaching rotations.

The highlight of the New Visions Program occurred during September of 2003, when the first graduate of the program was hired as a full-time teacher for a local school district. It is strongly believed that the success of the New Visions Education Program is in its curriculum. The impact of the science activities developed as a result of this research has strengthened the mission statement of the SCT BOCES New Visions Education Program:

“Educating our Best with a Mission to Educate Others.”

Further information on the Cornell University CCMR Educational Outreach Program may be obtained from Outreach@ccmr.cornell.edu (phone 607-255-9547). For more information on the SCT BOCES New Visions Program, contact the author.

Your Questions Answered

This section of *SER* responds to readers' queries, so please submit your question to The Editor at editor@ScienceEducationReview.com . Have that long-standing query resolved; hopefully!

How is the molecular structure of substances identified?

Whole books could be written about this topic, and probably have. The earliest structural determinations were made by inference from a variety of clues. An example is benzene, which Kekule figured out in a dream. Today, structure is determined primarily through x-ray diffraction, a technique that Nobel laureate Linus Pauling used extensively in studying the structure of matter, especially crystalline substances. The techniques used vary depending on the nature of the molecules being determined.

Harry Keller, USA

How long is a DNA strand?

How long is a piece of string? In the normal human cell there is approximately 1 metre of DNA molecule, but this is divided into 46 chromosomes (strands) of different lengths. Other species have more or less chromosomes than humans and therefore we presume more or less total DNA. How long is a single strand? Which strand do you mean?

Gary Simpson, Australia