Science Academy: Challenge of the Mind

During spring break, many students in Alabama live out their dream of spending a week at the beach. This past spring, 160 Alabama youths (grades 5–8) managed to live out their dream of spending the week at Alabama's first "Science Academy."

Our very successful Science Academy was modeled after the National Science Olympiad, a program which has generated as much or more interest and enthusiasm in today's youth about science as any other single program in the history of this nation. During the first three days of the Science Academy, students took a series of 10 minicourses to learn and prepare for the upcoming "Challenge of the Mind." Held during the last half day of the Science Academy, the Challenge consisted of a series of puzzles and problems associated with the minicourses. The students could solve these problems only if they had understood the content of the minicourses. But the Challenge was also designed so that students who participated fully in the minicourses could do well and win a medal.

The camp emphasized team effort, time management, learning and understanding, applying knowledge, having fun learning, helping each other learn, and problem solving.

Teams (10 participants with a uniform grade distribution) cycled through the 10 minicourses, completing activities designed to teach and review the concepts needed for the Challenge. The activity-oriented minicourses consisted of numerous small experiments and demonstrations. They also included practice exercises in the form of "puzzles" designed to stimulate the students' thinking and make sure they had captured the essence of the concept.

The Education Exchange highlights the experiences of scientists and engineers with local schools, along with helpful hints and resources. If you would like to share your own involvement in science education, contact: Finley Shapiro, Department of Electrical and Computer Engineering, Drexel University, Philadelphia, PA 19104, U.S.A. Phone (215) 895-6749; fax (215) 895-1695; e-mail: shapiro@ece.drexel.edu

I'd like to describe three of the more popular minicourses (Astronomy, Optics, and Simple Circuits) in some detail to give you a better idea of our format and philosophy.

Astronomy

The Astronomy minicourse, taught by David Sturm, a physics graduate student at Auburn University, consisted of three parts.

The initial part, Strange New Worlds, provided an audiovisual tour of the solar system using slides of the most recent planetary photos obtained from Earth-launched spacecraft. Students were exposed to often misrepresented facts about the planets, such as the old tale that Mercury always keeps one face turned to the sun and the other side in total constant night. Mercury actually rotates with a 58-day long "Mercury day." And Mercury is not the hottest planet either; Venus is. Other interesting information about each planet was also presented, even the more comedic ideas such as the fact that if a bathtub were found big enough, Saturn would float on the water (and leave a ring of course!).

The second part, A Solar Football Field, aimed at building knowledge of the scale of the solar system. The distance from the Earth to the sun was made to be 100 yards, the length of a football field. Then every other dimension was scaled down. Venus, for example, was a bead just a bit over 1/4 inch in diameter placed 70 yards from the end zone (the sun). Mercury was a tiny 1/10 inch diameter bead placed 30 yards from the end zone. This scale was continued away from Earth until we reached Neptune, represented by a table tennis ball 1.67 miles away! The students concluded that the solar system is mostly empty space, so that a mission to another planet has little room for error in the flight path! The model was extended to the nearest stars at Alpha Centauri, which on this scale are 250 miles away from the stadium!

The last part, Suntracking, introduced the sun's daily apparent motion across the sky. Easy-to-obtain materials were used to create a solar path planetarium on which the sun's path could be marked in hourly intervals. The key component was a plastic hemisphere (such as the inner clear bottom of a 3-liter soft-drink bottle) mounted on cardboard. The location of the sun was recorded by finding the point which casts a shadow on the observer. The students learned that in our area (far north of the Tropics) the sun can never be directly overhead, and that the sun does

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not always rise due east and set due west. The students left the Academy interested in tracking the sun during the various seasons of the year.

Optics

Students started this course, which I taught, by passing an intense white light through a prism to see the spectrum. Through experimentation they discovered that the prism did not color the light but rather bent (refracted) different colors different amounts and hence separated the colors. The students then learned that such colors as yellow and cyan in the spectrum resulted from the addition of different colors of light. After studying the addition of colored light, we studied the subtraction of colored light. Students practiced predicting the color from color subtraction by building four-pane colored cellophane windows and overlapping them in various orientations. They then constructed a film-can kaleidoscope. Next, students discovered the phenomenon of polarization and learned about several properties of polarizers and polarized light, including birefringence. Then the students built another kaleidoscope using cellophane tape and crossed polarizers. In order to explain how this kaleidoscope works, students had to have a good understanding of color subtraction and polarization. During the Challenge, students predicted the outcome of using various combinations of color filters and/or polarizing filters.

Simple Circuits

Jim Stagliano, a physics graduate student at Auburn University, taught this class acting as "Mr. Electron." He gave participants a handout featuring Mr. Electron, a cartoon character who led them through a "directed play" session. The session was a series of experiments dealing with the basic principles of electricity. The participants were also encouraged to play with the equipment independently. They discovered how to light a bulb with a battery and one wire, and then how to check for continuity. Next, they tested a mystery board (a board with 10 numbered contacts where only one works) to discover which points are connected together and which are not. Afterwards, they built their own board. Mr. Electron continued with activities which allowed the participants to verify Ohm's Law and to discover the properties of series and parallel circuits, measuring voltage, current, and resistance using digital multimeters. The participants built the circuits using resistors and a standard experimenter's breadboard that can be purchased at any electronics store. As a result, they became familiar with readily available off-the-shelf components and could purchase materials and continue experimenting on their own. The Challenge consisted of the lab exercises without the aid of Mr. Electron, requiring the students to rely on what they had learned.

The Other Minicourses

- Bridge Building: After discussion and demonstration of basic considerations, teams could design, build, and enter two bridges per team in the maximum load support contest.
- Keep the Heat: Students performed experiments to determine how to build the best calorimeter, and then tried to build the best calorimeter with the least mass. During the Challenge, the students tested the calorimeters and compared the results.
- Measurement: Students constructed the GEMS height-o-meter and then determined the height of several objects. The Challenge was to use the height-o-meter to determine the height of a dorm to the nearest inch.
- Mousetrap Vehicle: Students designed and built mousetrap vehicles to go the greatest distance. Students on the same team competed with each other to determine which two cars would represent the team at the final competition.
- Name that Organism: Students learned how to identify microscopic organisms. The Challenge consisted of identifying organisms and giving their common and scientific name.
- Science Crime Buster: Students learned laboratory techniques for isolating and determining elements in compounds and mixtures. The Challenge was to identify the elements in a mystery powder.
- Simple Machines: Students constructed several simple machines, discovered their principles of operation, and recorded data to determine the theoretical mechanical advantage, actual mechanical advantage, and efficiency. For the Challenge, students constructed a boom out of plastic straws, straight pins, and masking tape. The winning boom held a 50.0 gm mass at the greatest distance from the point of support for 10 seconds without collapsing.

Evening Programs

Besides the 10 minicourses, two other programs were conducted only in the evening. Each lasted two evenings and involved all the students.

The Picture This event was patterned after the popular game "Picture This" except that all the words were taken from standard junior high school science texts.

The Science Bowl was patterned after "College Bowl" with all the questions taken from standard junior high school texts. The final round was held in an auditorium at the end of the Challenge so that students could encourage their teammates.

The evening sessions also provided time to work on the mousetrap vehicles and bridges. Teams attended all sessions together, and helped each other master concepts and complete the practice exercises. They worked collectively to build their bridges and mousetrap vehicles and decide who should do which events during the Challenge.

Awards

At the awards ceremony, participants who placed first through fifth received an Olympic-style Challenge of the Mind medal. During the awards ceremony, as students cheered and congratulated each other for winning medals in the various events, it became apparent that we had managed to generate the kind of excitement and enthusiasm for learning and for excellence in science that is usually reserved for major sports events. These students will never forget their experience at Science Academy. Our evaluation after the Academy revealed that 82% of the students said that science was one of their favorite subjects, 84% claimed that the Academy increased their interest in science, and 79% said that they particularly enjoyed Challenge of the Mind.

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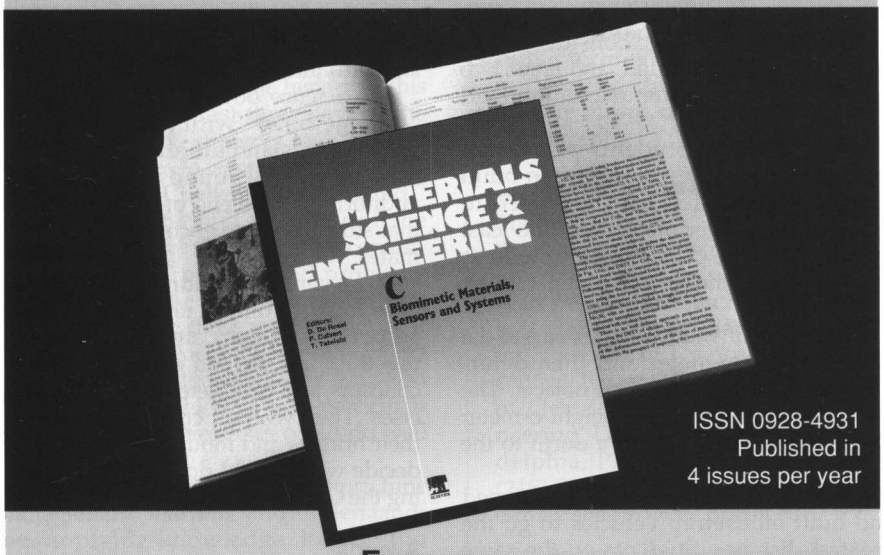

ISSN 0928-4931
Published in
4 issues per year

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About the Academy

The Science Academy was a special project of the Alabama Cooperative Extension Service under the direction of Tony Cook, state-level 4-H specialist. Because of Tony Cook's connection with the state 4-H program, the primary source of recruiting was through county agents and 4-H leaders. Since this was our first attempt to host a Science Academy, we decided to keep the enrollment around 150. Partial scholarships were provided to all participants, and some received full scholarships.

The Science Academy took place in a beautiful lakeside setting at a 4-H camp near Columbiana, Alabama. This camp has excellent indoor and outdoor facilities and an outstanding staff. Sponsors for the Academy were Alabama Power Company, Alabama Space Grant Consortium, and the Alabama Cooperative Extension Service. This Science Academy was deemed such a success by participants, staff, and sponsors that the 1994 Academy has already been funded and preparation for the minicourses is under way.

M. SIMON

For more information about the Science Academy, contact: M. Simon, Physics Department, Auburn University, Auburn, Alabama 36849-5311. Phone (205) 844-4337; e-mail msimon@physics.auburn.edu.

Marllin Simon *is an associate professor of physics at Auburn University, Auburn, Alabama. During the academic year he teaches large classes of engineering students and manages the undergraduate physics laboratory program. During the summer months he likes a change of pace and conducts five one-week Operation Physics Summer Institutes for as many as 150 middle school science teachers. Simon has an intense interest in science education and has received numerous teaching awards including the Southeastern Section of the American Physical Society's prestigious Pegram Award.*

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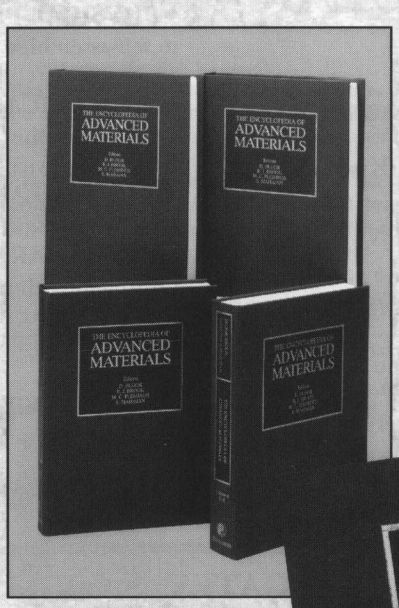

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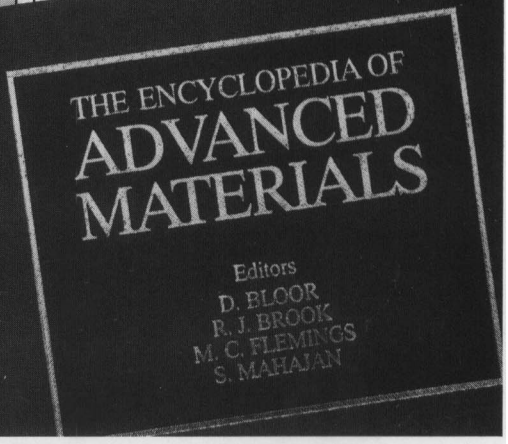

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