AC 2004-355: TECHNOLOGY APPLICATIONS FOR HIGH SCHOOL MATHEMATICS AND SCIENCE CURRICULUA

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Technology Applications for High School Mathematics and Science Curriculum

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The development of a larger pool of students for post secondary technology and engineering programs reflects an issue of national importance. The United States will maintain its position as the leader in scientific and technical innovations only if it keeps a vibrant and versatile workforce that will not only develop new technologies but support their manufacture. Fundamentally, this workforce must be a homegrown product of our secondary education system. Since the skill and expectations from this new workforce will be high, the challenge at this point is to increase the science and mathematics educator awareness of technology connections to their subjects. Ultimately, the requirement is to translate that awareness into curriculum.

The High School Technology Initiative, HSTI, is an NSF-Advanced Technological Education, NSF-ATE, Division grant that produces modules for use in high school mathematics, physical science, chemistry, physics and AP science courses. These modules represent a curriculum content resource for the high school mathematics and science educator. The material is available in as traditional and/or multimedia format.

This NSF Showcase Poster Session entry will present example module and module content that reflect the mission and objectives of HSTI. Specific modules will be highlighted that reflect how HSTI has integrated technology examples into Standards-based high school science and mathematics content. Examples presented will draw from semiconductor processing, LED applications, medical imaging, and other high tech technologies. Elements of HSTI's high school educator professional development program will also be presented. Finally, various ways that HSTI module can be used as pipeline tools for community college technical and engineering college programs will be provided.

Background

The High School Technology Initiative's goal is to develop up-to-date classroom materials for high school science and mathematics classes that address high technology as it relates to the concepts found in high school science and math courses. Everyday examples are employed to heighten and emphasize the impact that science and mathematics has on our

standard of living. The materials are intended to complement the teacher's current text based content and blend into existing or slightly modified lesson plans.

HSTI uses a CD vehicle to distribute its materials to teachers. Each CD is thematic, including 5 or 6 related units. Each unit contains classroom materials including handouts, worksheets, templates, PowerPoint presentations, activities and quizzes. Each unit contains some classroom materials based on selected technologies that are used to illustrate the science concepts in the unit in meaningful terms. Additionally, each CD module has a comprehensive educational video that introduces the technologies that are covered in the module. HSTI has recently completed its latest module CD, THE ATOM, that blends the atomic related topics within various grade level standard's based high school curriculums and technologies that have developed because of increased knowledge of the atom. The technologies introduced in the units of this module and how they are related to the science concepts covered in the six units are divided into 2 groups: technologies that rely on the properties of the electrons and technologies that rely on the properties of the nucleus. Light emitting diodes, smoke detectors, carbon dating, food irradiation; x-rays, and CAT scans are representative example technology applications used in the module. Each topic is structured to help make the science concepts related to atomic structure and properties more relevant to today's high school students.

HSTI Delivery Strategy

The chart below highlights the technologies covered in the HSTI Module on the Atom and the high school science and math topics that they are directly related to.

Technology	High School Science Topics	High School Math Topics
ATOM MODULE		
LED (light emitting diodes)	Electronic structure; transitions; wave particle relationships; quantized energy; spectroscopy	Simple and complex algebraic equations; inverse power functions
X-Ray and CAT Scans	Electronic structure; transitions; wave particle relationships; quantized energy; spectroscopy	Simple and complex algebraic equations; inverse power functions;
Food Irradiation	Properties of nuclear particles (gamma rays); balance equations	Algebraic arithmetic and balance equations
Carbon Dating	Properties of nuclear particles (beta particles)	Exponential functions (half life)
Smoke Detection	Properties of nuclear particles (alpha particles)	Algebraic manipulations
PROBLEM SOLVING MODULE		
Semiconductor Fabrication Processes	Balance chemical reactions; atomic structure; states of matter	Algebraic manipulations; geometry; significant figures; exponential notation; problem solving

In each of these topic areas, the intertwining of materials and reinforcement of leaning objectives is extensive. Although no specific presentation order for HSTI material is

required, most secondary science and mathematics educators that have used the material begin with the video presentation. The video provides a connection among the modules with in the CD and also provides initial facts, images, and concepts that set the stage for additional lesson plan structured activities. There are various resources available that blend into this lesson plan delivery structure. Each of the major topics, HSTI module section, has the same array of topic index titles; Presentations, Student Handouts, Student Activities, Worksheet Keys, Quizzes, and Quiz Keys.

Within each of these module sections there is a set of material that provides classroom ready content targeted for specific grade level implementation. For example, the Presentations topic is a collection of PowerPoint presentations. The level of intensity for these presentations varies from 9th grade physical science through 12th grade AP Physics or AP Chemistry. The instructor selects the appropriate presentation to meet the classroom needs. In addition, the PowerPoint formats vary from presentations that are extensively animated to the more traditional bullet or short phrase summary style. Finally, the PowerPoint files are easily accessible and users are encouraged to modify, alter and blend slides to affect a personalized rendering of the material.

This integration and intertwining of module materials continues with the other module section selections. For example, the Student Handouts are text-based documents that provide additional information to the students. This material reinforces visual images and ideas presented in the video as well as the classroom PowerPoint presentations. The Student Activities portion of the module contains exercises and "hands-on" activities that increase the repetitive nature of the learning experience as well as address different student learning styles. The Worksheet component of the module allows the instructor to direct homework activity toward the topics and concepts presented in the three previous leaning media. Finally, the Quiz section provides assessment opportunities with answer keys provided for each quiz.

HSTI Modules Access

The impression that high school science and mathematics educators do not have the materials or skills to accomplish their objective is for the most part a misconception. If anything, the high school science and mathematics professionals within our school systems have more than enough material and more than enough people telling them what has to be taught. The development of standards based teaching is not the topic or an issue for this paper. However, it is a reality that has to be dealt with if there is an expectation to change the content within a specific high school mathematics or science course. Teachers are constantly bombarded with new materials. Most of it in a multimedia formats. Most of the time, it is shelved, not enough time to examine it, or dismissed after a cursory review because it does not appear to facilitate their standards based teaching mission.

To avoid this fate for HSTI modules, the HSTI team has developed a Module Users Guide, MUG, for all HSTI modules. The MUG is a combination of "hands-on" workshops and materials that help high school educators become familiar with the CD structure. The MUG also gives the teachers background information about the technologies to increase their

comfort level with adoption of the material into their own courses. Finally, the MUG process identifies how and where HSTI materials match state driven standards.

HSTI products are free to high school educators but access to HSTI products is a 2-step process. First, the HSTI team conducts a "mugging" that itself is a two part process. The first part is a "hands-on" workshop with the CD so those teachers understand the structure of the CD and how to use it. The second part is a short lecture series on the technologies and engineering science behind them. Once this "mugging" is completed, teachers are given the modules with the understanding that they will help use in the feedback evaluation loop that has been developed.

To date, HSTI products have been implemented in several states. Schools in Florida, New Mexico, Oregon, and Colorado are using the first module, THE PROBLEM SOLVING MODULE, in the series. It is expected this second module, THE ATOM, will also be a popular and practical addition to the teacher's curriculum content tool box.

References

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Biographies

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ANDREW HOFF received his Ph.D. in Electrical Engineering from The Pennsylvania State University in 1988. Since then he has worked at USF in Tampa, Florida in the Center for Microelectronics Research and is presently an Associate Professor of EE. His research interests include the control of process related defects and contamination, plasma processing of materials, and process induced charging and associated damage in IC manufacturing.

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