Session 2530

Content Generation: Lessons Learned From a Successful High School Science and Mathematics Outreach Program

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Abstract

The High School Technology Initiative (HSTI) is an educational materials development team at the University of South Florida. This team is comprised of high school educators from Hillsborough and Polk Counties, Hillsborough Community College faculty, University of South Florida faculty, graduate students, animators and graphic designers. After developing its first educational module, "Problem Solving with High Technology Examples", HSTI secured NSF funding for the development of two additional modules, for testing of all three modules and for development of accompanying teacher training courses.

HSTI's goal is to create products that seamlessly integrate into the current high school curriculum, while providing high technology examples for the students and background materials for the instructors. From the beginning, HSTI's modules are created with the educators needs in mind. They are designed to supplement the current classroom curriculum, not supplant it. Each module is comprised of units that support the overall module theme. These units contain presentations, activities, handouts, exercises, and quizzes that the instructor can incorporate into their curriculum.

Content generation for the units within a module is a carefully managed process utilizing the resources from all of the development team members. This paper will present some of the lessons learned from development of module content to module testing, focusing on the intermediary steps of content development, technology infusion, and module organization. Hopefully, this window on our process will assist other developers who are working to enrich the educational resources available to high school science and mathematics instructors and their students.

Introduction

The High School Technology Initiative (HSTI) was formed to develop materials to supplement high school science and mathematics curriculum that convey methods of solving modern technological problems and emphasize how technology affects students' lives. By providing these students with an understanding of how to approach technology, we aim to increase and incite interest in the study of science and engineering disciplines. This initiative arose from the realization that high school students frequently fail to connect the basic scientific principles learned in their course work with the technological marvels that many of them make use of daily. The principles behind such items as portable phones and pagers, personal data assistants, along with more familiar high tech tools such as computers, pocket calculators, and TV/VCR's with remote control are a complete mystery [1]. An understanding of the interconnectedness of science and technology will provide the foundation for further education in a technology dependent world. The goals of the HSTI are to: 1) Facilitate the teaching of fundamental science and math skills through high technology applications and presentation techniques, and 2) Increase students' awareness and appreciation of the interdependence of science, mathematics, technology, and society. To accomplish these goals HSTI has formed an interdisciplinary team that develops educational modules that integrate into the existing science and mathematics curriculum. These HSTI modules are based on the merger of science and mathematics precepts with technology derived from these disciplines.

A key component in this initiative is the teacher who is responsible for the delivery and interpretation of the curriculum. Interactions with regional high school faculty over the past several years have resulted in three clear messages. First, teachers will not integrate a set of disjointed high technology materials and examples into their courses. Second, any materials provided must match the time constraints associated with typical lecture formats. Finally, any new educational resources must be consistent with the guidelines of a state approved curriculum. Cognizant of these constraints, our team of educators set about the development of technology based modules that could be used by high school faculty to enhance the presentation of their science and mathematics topics.

This paper presents some of the lessons learned in the development of our first two modules. Insights gained through the module development process are presented. Topic selection, content development, technology infusion, module organization and module testing are examined. Finally, a brief discussion of the management of our high school personnel resources is presented.

Topic Selection

The early stages of module development are focused on the selection of topics and the delivery approaches. High probability of use by high school teachers was the primary selection factor. To accomplish this task, the high school academic community was approached in a somewhat novel manner. Rather than go to the teachers with surveys and questions, our group offered workshops that allowed interaction with high school faculty as part of their professional in-service days for science teachers from across the county. As background information, Hillsborough County is the 12th largest school district in the country with 16 high schools, 150,000 students, and 8,000 teachers [2]. During this nominal half-day professional experience, local science teachers were provided with an introduction to vacuum technology with simple hands-on experiments and demonstrations that could be implemented in their home schools with minimal materials. Technology related content on applications of vacuum in integrated circuit manufacturing, fluid processing of materials, and environmental engineering were also provided.

Feedback from the teachers attending these workshops allowed our team to focus on those components of the workshop that were useful to teachers, and to identify content that required more development [3].

Two other important outcomes occurred during these workshops. Our group was introduced to a sample of teachers from across the region in a positive, collaborative manner. Second, the recruitment of outstanding advisory participants/educators, to help design effective module content and delivery methods, was facilitated.

In regular meetings with our growing group of university and high school educators, frank and open discussion provided insight into what practitioners would find useful in their course delivery. The principle findings revealed that high school faculty have a prescribed and rigid set of outcomes that must be adhered to, and are associated with the state mandated curriculum. Further, the timing of the delivery of topic materials is pre-established. Therefore, to have any probability of use by teachers, technology content loaded materials must conform to these pre-established time and sequence constraints, as well as provide mandated topically relevant content. In other words, developed modules must not only provide classroom materials with content that covers the same mandated science theory and practice, but also present a technology connection within the time frame allocated by the instructors current lecture format.

It should be noted that care was taken to determine and assess those topic areas that would provide both use and utility to faculty. In particular, effort was spent to identify and discuss areas and topics that would not be explored because they were generally too difficult for the teacher to deal with. As suggested, this difficulty was primarily due to time limitations. However, in some cases, topics were identified that, in the teachers' opinion, had skill requirements beyond the students' current academic level. These topics were either adjusted to the appropriate level or shelved to be used in a later module.

Content Development

The core content development takes place by the teacher. HSTI hosts a summer institute where the teachers are invited to the university for a period of five weeks. They are divided into teams, paired with graduate students, afforded the resources of the university, and set to the task of fleshing out the units within the module. After an initial brainstorming session where the topics for each unit are decided upon, the teams split up and focus on content development. This entails developing the presentation outline, handouts, exercises, and appropriate answer keys for the individual units. Since the summer institute is a short 5 weeks, time management is critical. We have found that a weekly meeting where all of the teams come together to discuss the materials they have developed for the unit at hand, provides the best communication. This process allows us to utilize our most important human capital, the teachers, to develop the backbone of the module. The summer institute format has proved to be an effective development tool, primarily because it provides a forum where there is open communication in a setting that enables, empowers, and entrusts our developers. An added benefit of bringing the teachers to the university is that working with university faculty and graduate students not only exposes them to new technologies, it also increases their proficiency with producing presentation materials.

Additionally, this increase in their technological savvy accompanies them back to their local schools.

Technology Infusion

During content development, the teachers are paired with university faculty and graduate students to identify technology applications that will complement the required content. Keeping these suggestions in mind, the university and community college team begins to research the possible technology connections. It is here that the development process starts to move from being driven by the standards and core curriculum to the high technology applications.

After identifying the technology applications that reinforce the science and mathematics lessons, the team begins to edit the materials already created. The presentations for each unit are refined first. During the summer institute, the teacher and graduate students prepared PowerPoint presentations for each unit. Initially, these presentations focus the curriculum concepts required in the courses. Using the identified applications, the presentations are modified to include high technology examples that serve to connect the basic scientific principles with the technological marvels we all encounter daily. Once these presentations are modified, they are presented to the teachers at one of our monthly group meetings. This allows the teachers input on the application and its level of appropriateness. If necessary, the presentations are further refined and represented to the group.

Once the presentations are well defined both in the core science and technology examples, the other materials for each unit are reviewed and adjusted to conform and support them. The handouts, worksheets, and quizzes developed by the teachers at the summer institute, are updated to include the prevailing technology examples. The interactive components of the units, computer based html flashcards, laboratory exercises, and computer-based java applets are created. Concurrently, the script and storyboard for the module video is started. The video concept is developed by the university and community college team members. It is designed as an overarching bridge connecting all of the units within the module. In most classes, it will serve as an introduction to the materials included in the module and will reinforce the lessons and examples presented there.

Module Organization

For each module a project manager is chosen to guide the development process and keep the team focussed on priorities. This leader is responsible for the module organization and compiles the materials developed by the team members and groups into the module architecture. A key to the success of the HSTI modules is the module architecture. The module must be user friendly enough that the educator feels comfortable with it, while at the same time, it must have a delivery method that connects with the students.

To accomplish the former goal, the module is compiled on a CD-ROM using standard html navigation. This allows the instructor to access the materials as if they were browsing online content via a fast connection. Additionally, the module includes an entire section, separate from the educational content materials, devoted to the use of the module. This section includes suggestions on how to integrate the module into the classroom, educational standards, assessment tools, contact information, and lesson plans. Aside from the background information provided, the most important information available to the user, from the instructor portion of the module, is the “Lesson Plans”. The Lesson Plans component is further subdivided to provide lesson plans for Physical Science, Chemistry, and Physics courses, with a guide of relevant topics for the mathematics user. Understanding that a HSTI module will never meet its educational objectives if teachers do not use it, these lesson plans suggest how the teacher can seamlessly integrate the units into their science and mathematics curriculum. They are developed in concert with the teachers on the development team, and those who have used the module in their classrooms.

In regards to connecting with the students, the HSTI modules strive to grab the student’s attention, maintain it, and then inventively use high-density information transfer to accomplish the desired lesson. Through trials in the classroom, we have found that the use of video to capture the student’s interest initially and get them involved works well. This dynamic introduction to the materials found in the module, leads the students to ask questions about the materials. The answers to these questions are then presented in depth by the teacher, in the course of their curriculum, using the module materials. This hybrid approach of the visualization of core concepts and technology connections, traditional didactic instruction, and hands on activities seems to increase the students’ knowledge of the interconnectedness of science and technology.

Module Testing

Evaluation and assessment of HSTI modules has a three-tiered structure with the first two of these aspects provided in each module. The first evaluation and assessment instrument determines how the teachers use a HSTI module as well as their like (dislike) of a module and/or a module unit. The second instrument focuses on whether or not students benefited from module use in the classroom. This evaluation is accomplished by the use of a pre- and post- use “Science and Technology Attitudes” survey. The third and final assessment and evaluation aspect is the "in-house" and "alpha" testing performed by the HSTI team as a module moves through production to a final product.

The primary lesson learned from our module evaluations is the difficulty in collecting the assessment data. The requirement of administering pre- and post- use questionnaires, as well as completing a module use survey, has proven cumbersome for overloaded teachers. Initially the forms were provided as Adobe pdf files on the CD-ROM, and the instructor was required to print out and collate the forms for return to us. This year, to increase the likelihood of response, HSTI provided evaluation packets to the teachers for each of their classes using the module. This package included color-coded printouts of the necessary surveys, scantron type bubble sheets for the student surveys, and a self addressed return envelope. This approach facilitated better response rates for evaluations.

In regards to teacher acceptance, the graphs in Figure 1 represent assessment from the first HSTI module, “Problem Solving with high technology examples”. These questions were asked of the teachers following their initial exposure to the module via the first phase of teacher training, the module workshop. The graphs summarize the responses from 92 teachers from 6 different states. These results reveal that the module does have a niche in the existing national curriculum and that the teachers think that their students will benefit by the use of these materials.

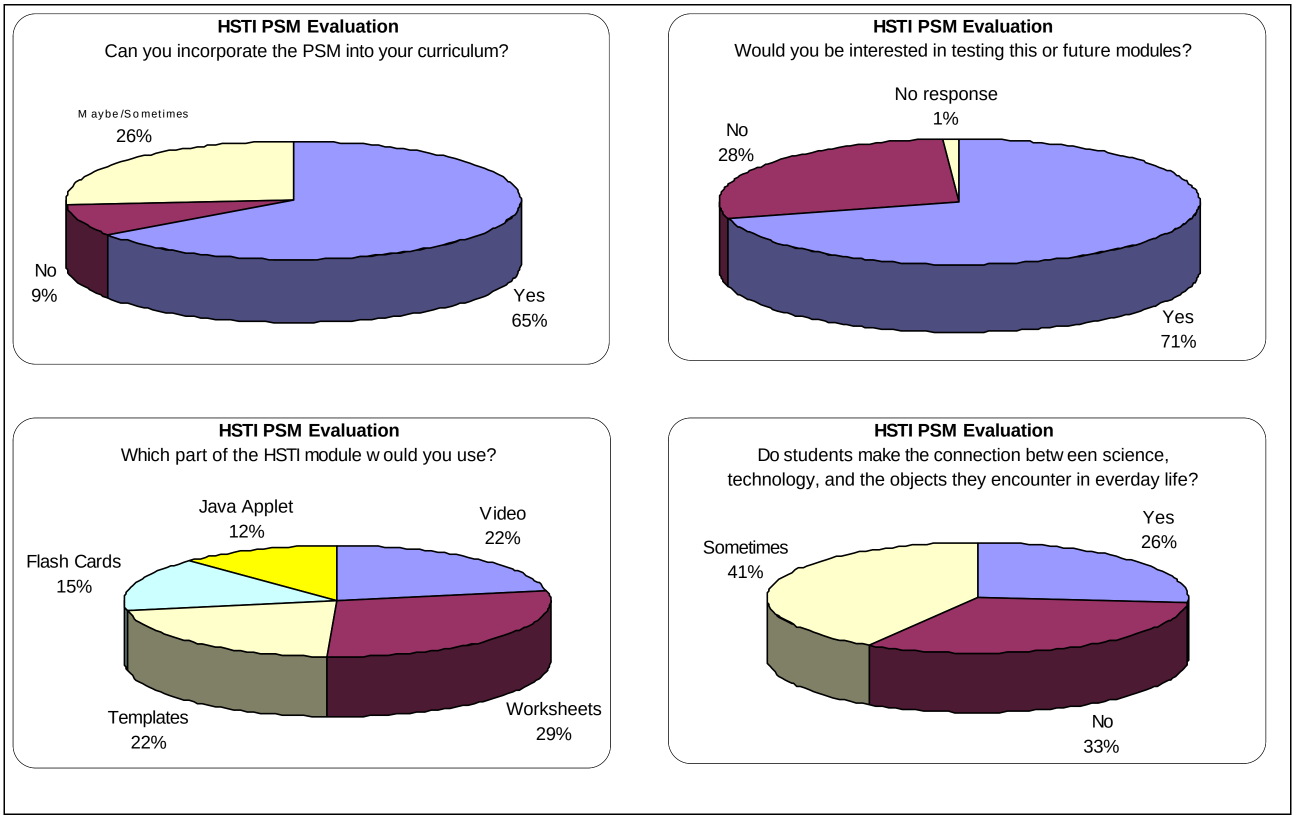

Figure 1 – Teacher Feedback

Continuous Improvement

As with any enterprise, successful or otherwise, there are always opportunities for improvement. In order to improve our content generation process, we debrief the development teams after the summer institute, share assessment results and feedback with the entire group, and finally, the management team incorporates suggestions into the plan for the next summer institute. In regards to content itself, we strive to include relevant topics given to us by the teachers and students through their feedback, make format changes that work better in the classroom, and refine our teacher training to make better use of the teacher's time.

Three examples of these improvements can be found throughout our first two modules. 1) Initially, the video played straight through from start to finish. Based on teacher feedback, and classroom observations, we found that many of the teachers stop the video playback, at key moments, to discuss the on-screen materials with the students. To facilitate this, we included pauses in the video at key times. 2) The lesson plans included in the module were initially static documents that listed the module resources recommended for each of the units. After teacher feedback, we included hyperlinks to the resources so a teacher could browse or retrieve the materials directly while looking over the lesson plans. 3) In early summer institutes, each teacher/graduate student team worked on one unit individually over the duration of the session. In the most recent summer institute, all the teams worked on the same unit synergistically for week before moving on to the next unit. This approach broadened the materials developed for each unit.

Conclusions

Content generation for the units within a module is a carefully managed process utilizing the resources from all of the development team members. From module topic selection through content development for the units within a module, technology infusion, module organization, and module testing, the process only succeeds through good communication. Our most valuable human capital is the teachers in the trenches that will use the materials in their classroom. These teachers work with us, from the beginning, to develop materials that they can and will use. The diversity of the development team and the module architecture are keys to the creation of our modules. Through the process we've described here, we have been able to create two modules that serve to strengthen students' scientific literacy and establish the connections between science and technology, hopefully engendering an interest in science and engineering careers. We hope that the insights presented here can assist you in the development of materials for your educational goals.

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