AC 2005-509: IMPACT OF A NSF ATE FUNDED HIGH SCHOOL SCIENCE AND TECHNOLOGY OUTREACH PROGRAM: EVALUATION OF H.S.T.I. MATERIALS

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Impact of a NSF ATE funded High School Science and Technology Outreach Program: Evaluation of H.S.T.I. Materials

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Abstract

The National Science Education Standards state that "any presentation of science without developing an understanding of technology would portray an inaccurate picture of science." It further notes; "High school students do not distinguish between the roles of science and technology". Today's high school students are exposed to an ever-increasing amount of high technology that impacts their everyday lives. Still, the number of students that possess knowledge or understanding of the underlying principles, or interest in the development and/or manufacturing background of these technologies is small. This lack of knowledge and interest has contributed to U.S. firms in the U.S. high-technology sector looking outside the country in order to find workers with the right skills. With these factors in mind, the High School Technology Initiative (HSTI) project was launched and funded by NSF-ATE.

HSTI offers materials that provide science and math content designed to connect students and teachers to today's technologies. HSTI materials are Modules and Module Usage Guides (MUG) developed for science, mathematics and technology teachers. The Modules are topic based, supplementary teaching tools, designed to connect science and technology. Module Usage Guide (MUG) materials are Workshops and Short Courses. The MUG Workshop is designed to familiarize the teacher with the structure of the HSTI modules and offer suggestions for classroom integration. The Short Courses are the professional development portion of the MUG. They are classroom-based, in-depth training on the technologies associated with the science presented in the respective module. In the past two years, 180 teachers have accepted HSTI modules impacting nearly 20,000 students.

During the HSTI project, we have used mixed methods of data collection, including online teacher surveys regarding the modules, post professional development surveys, student impact prereporting by the teachers, and direct observations. The purpose of our sampling was to create an accurate composite picture of the teachers and students exposed to the HSTI materials and collect data to improve our product and process. Our strategy was to primarily solicit responses from the teachers, due to the difficulty in surveying students directly. This poster presentation will offer an overview of HSTI materials, discuss the evaluation methodology, and present evaluation results.

Introduction

The National Science Education Standards state that "any presentation of science without developing an understanding of technology would portray an inaccurate picture of science." It further notes; "High school students do not distinguish between the roles of science and technology" [1]. Today's high school students are exposed to an ever-increasing amount of high technology that impacts their everyday lives. Still, the number of students that possess knowledge or understanding of the underlying principles, or interest in the development and/or manufacturing background of these technologies is small [2]. This lack of knowledge and interest has contributed to U.S. firms in the U.S. high-technology sector looking outside the country in order to find workers with the right skills [3]. With these factors in mind, the High School Technology Initiative (HSTI) project was launched and a proposal was submitted and funded (DUE 02-02373) by NSF-ATE. Project funds support the construction of three High School Technology Initiative (HSTI) modules. Two of the three modules, "The Problem Solving" Module and "The Atom" Module are completed, beta tested, and are in use in schools in eleven states (Arizona, California, Connecticut, Colorado, Florida, Idaho, New York, Oregon, Tennessee, Texas, and New Mexico). The third module, "Fields and Waves", is on schedule for completion by June 2005.

HSTI modules have proven to be an effective way for teachers to deliver science and math related content to students. They also present technology content lessons within the time frame allocated by the instructors' selected presentation format. The modules provide teachers multimedia presentation options for each lesson. Each module contains presentations, worksheets, in or outside class activities, as well as quizzes and tests. In summary, each HSTI module offers high school science and mathematics teachers curriculum content material that emphasizes technology as it relates to science and mathematics, as well as providing technology based multimedia options as delivery vehicles.

A HSTI module is developed not only with the high school science educator presentation in mind, but with science and mathematics content created as the high school curriculum has dictated. The HSTI development team consists of high school science teachers, university and community college professors, engineering Ph.D. students, and multimedia professionals. The typical mode of operation for the team is to review the topics currently presented specifically with the high school teachers. These discussions lead to the module's science and mathematics content as well as identification of the science, mathematics and/or technology standard that the material will address. Ultimately, the science and mathematics objectives are blended with technology and engineering related examples, to produce a module that integrates technology with the specific science principles and mathematics skills required of the lesson plan, which the module is designed to support.

The HSTI team believes that HSTI modules can be used to engender an interest in pursuing technology, engineering, or science related careers by providing students with connections between everyday examples of technology and their underlying science as part of the normal state mandated science instruction. Also, HSTI modules augment the high school science curriculum with technology content material that is standards based, has a positive impact on students, is attractive to the science and mathematics teacher, and is an effective, efficient and

appropriate approach to connect technology to fundamental science concepts and mathematics principles.

Evaluation of HSTI Module Usage

The major purpose of the evaluations done thus far, have been to study the acceptance, usability, and impact of HSTI materials (Modules and Module Usage Guides). Further, these evaluations were intended to provide objective, unbiased feedback to the HSTI team for the purpose of module refinement and guidance on development of future materials.

The following questions are central to the evaluation within the context and goals of each module and the overarching mission of the entire HSTI project.

- To what extent are students being exposed to HSTI materials?
- What materials are the teachers comfortable in using?
- What barriers to meeting student learning can be identified?
- To what extent are the stated goals and objectives of the project being met?
- Are the professional development opportunities offered by the MUG's beneficial?

During the HSTI project, we have used mixed methods of data collection. This include online teacher surveys regarding the modules, post professional development surveys, student impact prereporting by the teachers, and direct observations. These measures address the acceptability of a variety of school-based instructional and intervention strategies with teachers, parents, students, and consultants, and have been used in both analog and naturalistic settings. Acceptability measures contain common item stems (relating to, e.g., like, understand, easy to use, effective with students, use again, recommend to others), with varying rating targets (instructional or treatment strategies), and a common 5-point Likert response format (1 = strongly disagree, 5 = strongly agree). Measurement reliability is consistently high, as is construct validity with factor analyses typically yielding a single general factor of acceptability [4]. The purpose of our sampling was to create an accurate composite picture of the teachers and students exposed to the HSTI materials, and collect data to improve our product and process. Our strategy was to primarily solicit responses from the teachers, due to the difficulty in surveying students directly. Listed below are surveys that were administered:

- PSM & Atom Promissory Note Questionnaire (2002-03)
- PSM & Atom MUG Workshop Survey (2001-03)
- PSM MUG Short Course Survey (2002-03)
- Atom MUG Short Course Survey (2003-04)
- PSM & Atom Online Module Evaluation Survey (2004)

The Problem Solving Module (PSM) and Atom Module Promissory Note is the agreement between HSTI and the teachers planning on using the modules. Teachers are asked to sign the following statement upon receipt of a HSTI module: "By accepting this CD and/or video, I agree that I will use the material in my class(es) listed below and will provide information to HSTI for their internal use and for use in the NSF grant evaluation process." They are then asked to participate in module evaluation surveys, what course they will use the module in, and how many students will be exposed to the HSTI module materials. The questionnaire data indicates

that 180 teachers want to use the module in their classes exposing 20,000 students to the HSTI module materials. These teachers represent schools in 11 states.

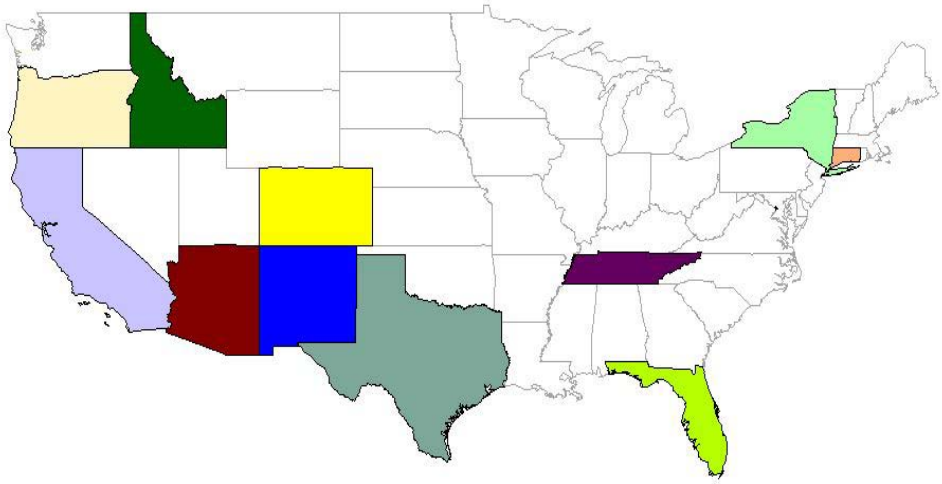

Figure 1 - States where HSTI modules are in use.

The PSM & Atom MUG Workshop is designed to familiarize the teacher with the structure of the HSTI modules and offer suggestion for classroom integration. Of the 171 and 107 respondents at PSM and Atom MUG events, respectively, 91.8% and 100% indicated that they can incorporate the module into the course that they presently teach. Many of the 8.2% that indicated that they could not incorporate the materials, teach Biology related courses for which there is not currently a related HSTI module. Testing the science/technology student connection hypothesis, before modules were introduced, teachers were asked, "Do you feel that students make the connection between science, technology, and the objects they encounter in everyday life?" The responses, from the 282 respondents, indicate that 74.5% feel that students do not, or only sometimes, make the connection.

Question 1: Can you incorporate this module into the courses you teach?
Yes No Maybe
Question 2: If "No" why?
Question 3: What topics would be useful for a future module?
Question 4: What courses do you teach?
Question 5: Does your classroom have? (check all that apply)
TV & VCR Computer & Projector Overhead Projector Computer for each student
Question 6: Which parts of this module would you use? (check all that apply)
Video Worksheets Templates Flash Cards Java Applet PowerPoints
Question 7: Would you be interested in field-testing this or future modules?
Yes No Maybe No Response
Question 8: Do you feel that students make the connection between science, technology and the objects they encounter in everyday life?
Yes No Sometimes

Figure 2 – HSTI MUG Workshop Survey

Table 1 - PSM Workshop Results:

Question 1: (n=171)						
Yes		No		Maybe/Sometimes		
61.40%		8.19%		30.41%		
Question 5:						
TV & VCR	Computer & Projector	Overhead Projector	Computer for each student			
146	90	136	23			
Question 6:						
Video	Worksheets	Templates	Flash Cards	Java Applet	PowerPoints	No Response
100	131	108	81	55	29	2
Question 7: (n=170)						
Yes	No	Maybe	No Response			
65.88%	31.18%	1.18%	1.76%			
Question 8: (n=173)						
Yes		No		Sometimes		
25.43%		26.01%		48.55%		

Table 2 - Atom Module Workshop Results:

Question 1: (n=107)			
Yes	No	Maybe/Sometimes	
94.39%	0.00%	5.61%	
Question 5:			
TV & VCR	Computer & Projector	Overhead Projector	Computer for each student
105	57	90	9
Question 6:			

Video	Worksheets	Templates	Flash Cards	Java Applet	PowerPoints	Handouts
95	98	64	55	n/a	90	90

Question 7: (n=107)			
Yes	No	Maybe	No Response
72.90%	25.23%	1.87%	0%

Question 8: (n=109)		
Yes	No	Sometimes
25.69%	6.42%	67.89%

The PSM and Atom MUG Short Courses are the professional development portion of the MUG. They are classroom-based, in-depth training on the technologies associated with the science presented in the respective module. They are intended to educate the teacher on the technology beyond what is provided in the module, so that the teacher feels comfortable with the technologies and has knowledge to adapt the module materials for their classroom. The surveys used here are primarily intended to provide feedback to the MUG presenters and material developers on the effectiveness of the short course. A full table of these results can be found in the supplemental section. The results of the overall evaluation questions for these short course evaluations (based on a scale of 1 to 10) show teachers rated the MUG Short Course a 8.4 and 8.2 for the PSM and Atom, respectively.

Please rate the topics of the short course by using the following scale:
5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree, 1 = strongly disagree

1. The Problem Solving Module Short Course raised my understanding of the technology that supports the semiconductor manufacturing industry.
2. The Photolithography hands-on activity was easy to understand and perform.
3. The Diffusion hands-on activity was easy to understand and perform.
4. The Overview of Semiconductor Manufacturing presentation increased my understanding of this topic.
5. The Silicon-from-Sand presentation increased my understanding of this topic.
6. The Photolithography presentation increased my understanding of this topic.
7. The Diffusion presentation increased my understanding of this topic.
8. The Plasma Etch presentation increased my understanding of this topic
9. I will use the knowledge gained from this short course in my classroom.
10. The video, handouts, and presentations enhanced and reinforced my learning of the topics.
11. The short course topics reinforced the science & technology aspects of the HSTI Problem Solving Module.
12. What would make the short course better?
13. What was the best thing about the short course?
14. What was the worst thing about the short course?
15. Will you be able to use the hands on activities in your classroom?
    Yes No If yes, what class?
16. What should we add to this short course?
17. Please rate the overall PSM Technology Short Course on a scale of 1 (lowest) to 10 (highest).

Figure 3 - PSM MUG Short Course Survey (2002-2003)

Table 3 – PSM Short Course Results

Question	Responses					n
	5	**4**	**3**	**2**	**1**	
1	52	33	3	0	0	88
	59.09%	37.50%	3.41%	0.00%	0.00%	
2	29	9	0	0	0	38
	76.32%	23.68%	0.00%	0.00%	0.00%	
3	29	9	0	0	0	38
	76.32%	23.68%	0.00%	0.00%	0.00%	
4	39	48	4	1	0	92
	42.39%	52.17%	4.35%	1.09%	0.00%	
5	27	39	2	2	0	70
	38.57%	55.71%	2.86%	2.86%	0.00%	
6	42	40	8	3	0	93
	45.16%	43.01%	8.60%	3.23%	0.00%	
7	10	4	1	0	0	15
	0.00%	0.00%	0.00%	0.00%	0.00%	
8	34	28	6	1	1	70

	48.57%	40.00%	8.57%	1.43%	1.43%	
9	23	42	17	7	91	91
	25.27%	46.15%	18.68%	7.69%	2.20%	
10	37	44	4	1	0	86
	43.02%	51.16%	4.65%	1.16%	0.00%	
11	45	36	9	1	1	92
	48.91%	39.13%	9.78%	1.09%	1.09%	
17	Average rating = 8.35					90

Please rate the topics of the short course by using the following scale:
5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree, 1 = strongly disagree

1. The Atom Module Short Course raised my understanding of the technologies associated with nuclear and electron cloud processes.
2. The X-Ray hands-on activity was easy to understand and perform.
3. The L.E.D. hands-on activity was easy to understand and perform.
4. The Gamma Irradiation presentation increased my understanding of this topic.
5. The X-Ray presentation increased my understanding of this topic.
6. The L.E.D. presentation increased my understanding of this topic.
7. The Analytical Tools presentation increased my understanding of this topic.
8. I will use the knowledge gained from this short course in my classroom.
9. The video, handouts, and presentations enhanced and reinforced my learning of the topics.
10. The short course topics reinforced the science & technology aspects of the HSTI Atom Module.
11. What would make the short course better?
12. What was the best thing about the short course?
13. What was the worst thing about the short course?
14. Will you be able to use the hands on activities in your classroom?
    Yes No If yes, what class?
15. What should we add to this short course?
16. Please rate the overall Atom Module Technology Short Course on a scale of 1 (lowest) to 10 (highest).

Figure 4 - ATOM MUG Short Course Survey (2003-04)

Table 4 – Atom Short Course Results

Question	**Responses**					**n**
	5	**4**	**3**	**2**	**1**	
1	40	44	5	1	0	90
	44.44%	48.99%	5.56%	1.11%	0.00%	
2	54	31	5	0	0	90
	60.00%	34.44%	5.56%	0.00%	0.00%	
3	40	37	11	2	0	90
	44.44%	41.11%	12.22%	2.22%	0.00%	
4	49	32	6	3	0	90

	54.44%	35.56%	6.67%	3.33%	0.00%	
5	35	42	11	2	0	90
	38.89%	46.67%	12.22%	2.22%	0.00%	
6	42	37	9	2	0	90
	46.67%	41.11%	10.00%	2.22%	0.00%	
7	31	31	29	0	0	90
	33.33%	34.44%	32.22%	0.00%	0.00%	
8	36	44	8	2	1	90
	40.00%	48.89%	8.89%	2.22%	0.00%	
9	49	39	2	0	0	90
	54.44%	43.33%	2.22%	0.00%	0.00%	
10	47	35	8	0	0	90
	52.22%	38.89%	8.89%	0.00%	0.00%	
16	Average rating = 8.2					90

The Online Survey response rate for the PSM and Atom modules is very low. Thus far, demographic data has only been collected from 25 teachers and module evaluation data from 16. The demographic data reveals that the 25 teachers have used the modules in the classroom with 2819 students. The module evaluation data reveals that on a Likert scale of 1 to 5, with 1 being strongly agree and 5 being strongly disagree, teachers agree (2.1, average value for the PSM) and strongly agree (1.0, average value for Atom) with the statement that "the HSTI materials helped my students to see the connections between science, math and technology".

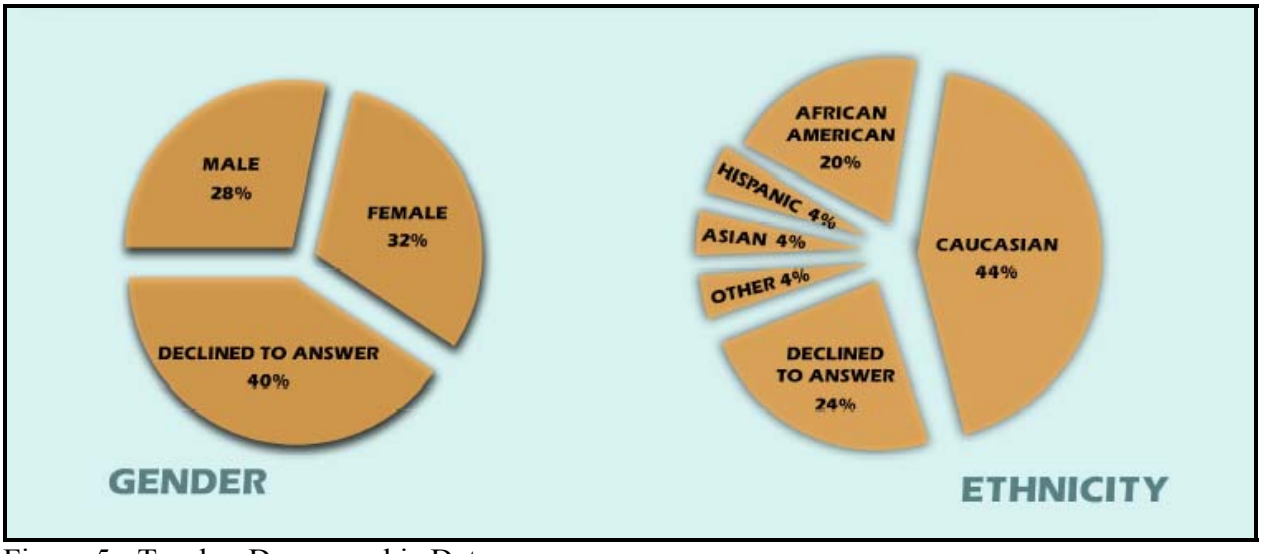

Figure 5 - Teacher Demographic Data:

Table 5 - Module Usage as reported to online survey

	PSM	Atom	Total
Teachers	17	8	25
Students	1991	828	2819

Table 6- Online Module Evaluation Results:

	PSM		Atom	
	mean	**std. dev.**	**mean**	**std. dev.**
Questions 1 - 8: 1=strongly agree, 2=agree, 3=neutral, 4=disagree, 5=strongly disagree				
1. I was comfortable using HSTI materials in my class.	1.6	0.7	1.3	0.6
2. The HSTI module helped me use my prep time more efficiently.	2.2	0.9	1.3	0.6
3. The students were very attentive to the lesson when I used the HSTI materials.	2.0	0.9	1.3	0.6
4. There were fewer disciplinary distractions during the HSTI module presentation.	2.7	1.3	1.3	0.6
5. The HSTI materials helped me reach the required curriculum requirements for my class.	2.2	1.2	1.0	0.0
6. The HSTI materials were easy to use.	2.2	1.2	1.0	0.0
7. The HSTI module generated the level of enthusiasm I expect in my class.	2.5	1.4	1.0	0.0
8. The HSTI materials helped my students to see the connectedness between science, math & technology.	2.2	1.0	1.0	0.0
Questions 9 – 12: 1=Yes, 2=No				
9. Would you use this HSTI module again?	1.0	0.0	1.0	0.0
10. Would you try another HSTI module on a different topic?	1.0	0.0	1.0	0.0
11. Will you incorporate HSTI materials into your regular class lessons?	1.0	0.0	1.0	0.0
12. Did you change any of the HSTI materials in this module to better suit your own class?	1.0	0.0	1.0	0.0

Conclusion

HSTI materials (Modules and Module Usage Guides) have been developed to improve teacher effectiveness when connecting science and mathematics to every examples of technology. In the past two years, HSTI materials have been distributed in eleven states, impacting 180 teachers and nearly 20,000 students. The evaluation measures were designed to create an accurate demographic of the teachers exposed to the HSTI materials, and collect evaluation data in order to improve our product and process. From the metrics assessed thus far, we can conclude that the HSTI materials are being accepted by teachers and are improving the classroom curriculum.

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