Assessment of an Engineering and Technology Summer Program for Underrepresented Students

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Abstract

Harrisburg Area Community College (HACC) offered and administered three-week summer programs for high school students from 1993 to 1997 inclusive. The primary goal of the Engineering and Technology Summer Institute (ETSI) was to provide high school students with interests in mathematics and sciences a preview of engineering studies at the college level. The students were chosen from populations that were underrepresented in the engineering profession. At HACC we sought to accept females and minorities into the program.

We were relatively successful with our student enrollments. The curriculum changed slightly over the five-year span of the program, but the project component and the Friday field trips remained constants throughout. HACC intends to retool and reinstate the institute. The funding source changed during that time span, and we will need to revise the program prior to soliciting new sources.

Original Grant

Faculty from the Mathematics, Engineering, and Technology Division supported the college's Office of Institutional Development in writing the original grant. The proposal was to provide high school rising sophomores the opportunity to experience engineering at the college level. We planned advanced course work that would be different than what the students would see during the school year. Also, we wanted the students to work with practicing engineers on team projects. The team projects would be practical applications of engineering design and would the basis for written reports and oral presentations by the students.

The Office of Institutional Development recognized the potential of involving some of the college's corporate benefactors in special projects. A member of that office wrote a general proposal for funding a summer program for minority students. As there was no request for proposals, the original concept was without a specific discipline until the faculty from the Mathematics, Engineering, and Technology Division were asked to consider the idea. From that combination we fashioned the Engineering and Technology Summer Institute (ETSI) for a three-week program that could serve fifteen high school students.

After one potential sponsor rejected the proposal, Sprint/United Telephone of Carlisle, PA agreed to fund the project. One stipulation made by Sprint was that at least some of the students be from the company's service area. Sprint made a donation of $15,000 to be used for the project in the summer of 1993. We identified the areas of Carlisle and Perry County, which were within the company's service area, and Harrisburg, which was not but is the largest urban area that the college serves. We enlisted the help of high school counselors at four area high

schools to identify fifteen students who had advanced standing in math and science courses and had at least a passing interest in engineering.

The Program

We developed the summer program to be three weeks of seven-hour days. Each day would include a one-hour break for lunch and recreation as the students were given meal tickets and invited to use campus facilities. The college has closed on Fridays during the summer, so we developed a curriculum based on 72 contact hours dividing that in half for classroom work and half for project time. We included English, mathematics, chemistry, computer-aided drafting, and computer programming in the course schedule. As the institute evolved over the years, we added sciences and speech to the class schedule. Table 1 includes the courses in the curriculum and the hours devoted to each subject. Beyond the 72 hours of course and project work were two six-hour field trips and a two-hour concluding luncheon. This schedule represents the 1996 institute. The first two Fridays of the Institute were dedicated to off-campus trips to local industries. Over the years we visited Sprint/United Telephone, Three Mile Island, True Temper, and Keystone Railway Equipment. On the third Friday we had a luncheon at which the students presented the findings of their project work to faculty, family, and friends.

Subject	Hours
Welcome/Orientation	1.5
Library usage	1.5
Internet instruction and usage	4.5
English	4.5
Speech	4.5
Math	4.5
Physics	3
Chemistry	3
CAD	4.5
3D Studio	4.5
Projects	36

Table1: Institute Curriculum from 1996

Classroom activities were tied together and most were linked to engineering and technology project work. The CAD and 3D Studio instruction was generic to all students, but for those project groups, which presented drawings for their designs, the instruction became more specific to their needs during the Institute. The English, speech, library, and Internet classes were based on researching, technical writing, and interpersonal communications. Written technical reports were required of all project teams, and those reports were created and edited in the English classes. Project teams also gave formal oral presentations at the luncheon having worked on the requisite skills in the speech classes. Math, physics, and chemistry classes were general in nature, but all were purposely experimental and applied. All three classes dealt with topics that went beyond the traditional high school curricula.

Project topics were varied. In one particular year, 1996, the projects were as follows. "Swimming Pool Bulkhead Design." "Analysis of Acid Rain in Harrisburg." "Environmental Analysis of VCR Design." "Design of a Home for the Physically Challenged." Students were

given project proposals made by the mentors for the various projects. The students were encouraged to choose their projects based on their interests. Mentors worked with the project teams in labs and in the field. The bulkhead and home design teams produced engineering drawings of their work. The acid rain team conducted experiments and presented the results. The VCR team disassembled a VCR, measured and weighed its contents, and made recommendations on how the design could be improved to reduce the amounts and types of material used.

Past Institutes

Sprint/United Telephone supported the program in whole in 1993, 1994, and 1995 and in part in 1996. The HACC Foundation was responsible for funding the remainder of 1996 and the 1997 Institute. Whereas Sprint supported the Institute by providing funds in each of the first three years, we had to prepare a proposal for the college's Special Initiatives Grant program. That proposal was for funds provided by the college's foundation to continue in the fourth and fifth years. Sprint's generous grants helped the Institute begin and grow. However, downsizing of the company's operations in the Harrisburg-Carlisle area the college its Institute funding.

The HACC Foundation rejected the proposal for a sixth year suggesting that the program be included within the operating budget of one of the college divisions. As of this time that has not happened, so we are at the stage of assessing the program for potential revision. We have been considering funding sources both internal and external to the college.

The Institute Students

Sixty-four different students from nine local high schools and two out-of-town schools participated in the five institutes. Of those, ten students came to a second institute, so we had a head count of seventy-four students in the five years of the program. It is significant that ten students returned for a second Institute, and two students were younger siblings of previous students. Thirty-two students, or exactly one half, were female. Thirty-three participants were African-American, five were Asian-American, three were Latino, and two were recent Russian immigrants. Table 2 is a summary of the student participants by gender and cultural background.

Female	36
Male	36
African American	33
Asian American	5
Latino	3
International	2
Caucasian	29

Table 2: Student Demographics

As our goal was to attract underrepresented students to engineering, we succeeded. Engineering has traditionally been a profession with a large Caucasian male population. Of the sixty-four institute participants, twelve were white males. Of those, two were the Russian immigrants, five came from rural schools, and the other five came from typically urban schools.

Table 3 is a comparison of ETSI students to HACC engineering student composition and national averages. The ETSI percentages are based on the 72 students in the program counting

the two recent Russian immigrants as Caucasian males since the other data does not include international students. The HACC data are from a five-semester period from 1998 to 2000 of students in the Statics courses in either the engineering or the engineering technology programs and are based on 98 students total. The national averages are for total undergraduate engineering enrollments for 1997 [1].

	ETSI	HACC	National
Female	50%	9%	19%
Male	50%	91%	81%
African American	46%	1%	6.8%
Asian American	7%	13%	10.8%
Latino	4%	0%	8.4%
Caucasian	43%	86%	74%

Table 3: Comparison of Student Body Composition

In comparing the institute to HACC engineering enrollments in general and national undergraduate engineering enrollment, it is obvious that we met our goal with females and African American students. The institute was behind HACC in general and national enrollments with Asian American students but ahead of HACC with Latino students.

Program Objectives

There were a few stated objectives that we set out to achieve with the institute. They were:

1. We wanted participants to learn from engineers about how the profession fits in today's work place.
2. We wanted participants to learn which courses are in an engineering program at the post-secondary level and to learn what would be expected of them in a college setting.
3. We wanted participants to work together as team members to define a problem, research potential solutions, and develop practical recommendations.
4. We wanted to motivate the participants to learn more about engineering and technology during their secondary school programs so they are better prepared to make their career decisions.

What Worked Well

When measured against the stated objectives, the Institute met each one during each year of the program. We had engineers representing various disciplines including mechanical, electrical, civil, environmental, construction, and chemical. Students had the opportunity each year to choose with which of the project teams and engineering mentors they wanted to work. Students were given a college-type program schedule for the purpose of exposing them to a post-secondary setting. Courses that are part of a typical engineering program including advanced mathematics, physics, chemistry, CAD, written and oral communications, were on the schedule. Students had written assignments in the forms of journals and reports. Each project team was responsible for written and oral presentations. The team projects covered half of the program time. Student teams defined a problem, researched the options, analyzed the results, and

presented the findings. Students relied on each other and their engineering mentors for feedback and interaction.

The final objective of giving the students an experience that could help them decide what programs and courses to follow in high school was also met. We know that most of the sixty-four students did not choose engineering as their initial major once they reached college, but most did pursue programs in the natural or physical sciences or in technology fields.

At last count twenty-one of the students have enrolled in HACC for at least one credit or non-credit course. There are currently three students who are enrolled in degree programs. While recruitment of Institute students into HACC was not a goal, providing them with the experience to interest them in further education was. We have parents' testimonials that the Institute did help guide their children to continue their studies with at least a couple receiving scholarships to institutions such as West Virginia University and the University of Maryland Baltimore County.

Other parts of the program that received positive comments from participants included the trips (they liked the visits to Sprint very much), the use of the college's resources (they used the recreational facilities and the computer labs), and the freedom of the college schedule (they had too much freedom at times).

What Didn't Work As Well

We recognize that when recruiting students to the Institute we limited our range of high schools from which we chose. HACC serves a three-county area that includes twenty-two sponsoring school districts. A more inclusive Institute should be more comprehensive in coverage. We did focus on the Sprint service area that intersected the college's sponsor area due to the company's request.

Relying on the high school counselors to aid in recruiting students for any program has proven to be marginal at best. There are some secondary schools where communication of special programs to the right students works better than at others. Not to fault the schools entirely, some years we provided less lead-time in the recruiting process than we did in others. The college does maintain active databases for high school students in various areas. One source for the engineering and technology database is the list of students who attend an annual Engineering Career Day during Engineers Week in February. That database was not helpful to the ETSI recruitment process as most students included there are juniors and seniors. Radio advertising was done in a couple years with moderate success. Using the college's contacts with local churches did prove beneficial for the last year of the Institute. Those churches with active youth groups were the most helpful.

Identifying the best student audience for the Institute was based on the objective of having their experience with us be useful in choosing their high school courses. To that end we chose the students who were entering 10^{th} grade as those who would benefit most. There were other factors that validated our choice for very different reasons. Students younger than 10^{th} grade age were less apt to meet the rigors of the Institute in terms of the homework and teamwork required. Maturity of the individual was certainly a factor, but so was dealing with a college schedule for those who had yet to follow one from high school.

At the other end of the spectrum were the students who were beyond 10^{th} grade. The automobile driving age in Pennsylvania is 16 years, and many students get their licenses during their 11^{th} grade year. For those who came to the Institute of driving age, as long as they had a

car available, they tended to leave before the end of the day. Most of these students were responsible enough to come to the Institute daily and arrive on time; however, the temptation to leave early on a summer's day was too great too often.

From the student's evaluations of the program there were a couple facets of the program that consistently received negative comments. When we started the Institute we often had 90–minute classes for most of the academic courses. The students didn't like the length of those classes, so we did change most lecture classes to 45 minutes. Laboratories in CAD and sciences were acceptable in longer time periods. Another area the students identified for improvement was the workload expected. As can be expected these high school students have a limited patience for schoolwork in the summer. They did not often take kindly to homework assignments from the Institute. Most students were successful in completing assignments during the classes, but homework was another issue.

We did have one negative comment from a student's guardian, her grandmother, who felt the students were given too much free time to wander about the campus on their own. Whereas HACC maintains a visible, uniformed security patrol at all times, the comment suggested concern for high school students at the college. Each year we did hire teaching assistants who acted as chaperones as well as laboratory aides and project coordinators. It was with the help of the assistants that we were able to keep our eyes on our Institute students.

Benefit to the College

Harrisburg Area Community College has as one of its primary objectives the creation of a multi-cultural environment on campus and in the classroom. The nature of the Institute is to include those individuals from various backgrounds who don't often receive support to pursue engineering and technology as career choices. Our student recruitment spanned urban and rural areas, crossed racial lines, and attempted to reduce the gender gap in the engineering classroom. HACC does benefit as a college when students from multi-cultural backgrounds are brought together for a program such as this. The participating faculty and staff also benefit from the interaction with these students as the unique perspective from many cultures broadens any engineering project application.

Other benefits to the college include the use of the Institute as a recruiting tool. Public perception of the college also benefits from such a program as the Institute enjoyed newspaper and television coverage. Lack of funding for 1998 did temporarily halt the program, but we at the college recognize the benefits to our service area and expect to begin anew as early as 2002.

The Next Step

The obvious next step is to investigate additional funding opportunities to resume the Institute. There are local and national private organizations that provide funding for programs similar to ETSI. We don't expect a private corporate donation to fund the Institute in total, so independent organizations may be the best alternative for funding. Designing the Institute to handle fifteen students per session seems to be optimal. Including the courses and projects as we have in the past has met the objectives of introducing students to an engineering curriculum as well as challenging the students to be productive in completing projects. Recruiting female and minority students meets the main objective of the program to involve the underrepresented population in engineering.

We need to broaden our recruiting effort to offer the opportunity to participate to a larger portion of the college's service area. We need to keep the program curriculum dynamic enough to incorporate new technologies, such as programmable logic controllers and solid modeling. We need to arrange for meaningful trips to businesses and industries that are informative and as interactive as possible to provide positive experiences. We need to recruit female and minority faculty and engineering mentors to serve as role models for the students in the program.

Whereas the funding directly from the college is no longer available, the college will provide in-kind support for such a program. We need to take what we can get from the college and get what we can from elsewhere.

Bibliography

1. National Science Foundation. "Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000." http://www.nsf.gov/sbe/srs/nsf00327/start.htm, (4 March 01).

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