The Young Scholars Summer Program in Electronics and Computers

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Abstract:

The Electrical Engineering Technology department at Indiana University Purdue University Indianapolis has hosted classes for the Young Scholars summer program for three years. The classes offered through EET have been primarily open for enrollment to students entering grades 8 through 10 (one course has been offered for grades 5 through 7). The first course, Electronics, has been offered all three years and has traditionally been the most popular course offered throughout the Young Scholar program. A Peek Inside the Computer, a class on computer software and hardware, was developed this past summer for the first time. Both courses were filled to capacity, and generated very positive feedback. Every session involves hands-on activities, with lecture content tailored to the lab. This paper will describe the typical students, the curriculum and projects, and important points to making this and similar programs successful.

Introduction:

The K-12 students of today are potentially the college students of tomorrow. In many cases, their math and science classes may be weak, and they may have little understanding of engineering and technology. The IEEE has identified one of its main goals as "teaching K-12 students the importance of engineering" [1]. Involving potential students on campus with fun and educational activities should stimulate an interest in college[2], hopefully in your discipline, and if all goes well, may encourage them toward your department!

The Young Scholar Program - General Overview:

The Young Scholar program at IUPUI (Indiana University Purdue University Indianapolis) was started more than ten years ago, and has been administered through the Department of Education for the prior two years. Until three years ago, all of the courses offered were in the liberal arts. In the past three years, two classes have been

developed for the Young Scholars program within Electrical Engineering Technology - *Electronics* and *A Peek Inside the Computer*.

The Young Scholars program is different than the typical multi-day resident "camp" experience found at many Universities over the summer; it is similar to a day-camp setup. Literature is sent to interested students and schools in the Indianapolis and surrounding areas inviting students to attend. Students are broken into groups based on grade; Early Scholars are from first and second grade, Beginning Scholars are from grades 3 and 4, Junior Scholars are from grades 5-7, and Senior Scholars are from grade 8 through 10. *Electronics* has been offered once for the Junior Scholar group and four times for the Senior Scholar group, while *Computers* has been offered once to the Senior Scholars. Typical class sizes run from six to 20 students per class. *Electronics* and *Computers* have had approximately 25 students each time they were offered (maximum class size of 20 was raised to meet demand).

Students enroll in the program for one week at a time (the entire program runs through four weeks). A day at Young Scholars begins at 8:00 a.m., and after a camp meeting, students have class for about two hours in the morning. This is followed by a mini-class, usually something fun and active (Line Dancing, Exploring Nature, etc.). After lunch is another two-hour block for their main class, followed by recreation activities, with the day ending around 4:00 p.m. This gives the students four hours per day in class for one week, or 20 classroom hours. This is a lot of time to hold the attention of students the fifth and tenth grades, so explanations must be to the point and accompanied with hands-on activities. More information about the Young Scholars program in general, including fee and financial aid structure, can be found at http://www.iupui.edu/it/edschool/ysp.htm .

Courses in Technology:

The *Electronics* course was the first developed. It has been presented twice each summer for the Senior Scholars students, and once last summer for the Junior Scholars (grades 5-7). The electronics classes have always been one of the first classes filled to capacity. There have been 4 to 6 students that have enrolled two summers in a row, which means that many of the hands-on activities must be modified from year to year.

A Peek Inside the Computer was developed in response to demand, and for more variety for repeat students. This class has a strong focus on computer hardware and programming. It was developed and presented for the first time last summer for the Senior Scholars.

A course called *A Survey of Technology* was developed and presented once. This course was designed to show students the differences between engineering and technology disciplines by introducing each engineering and technology program during one class period, which proved to prohibit hands-on activities.

Electronics:

The course in electronics was intended to be a fun, hands-on experience for the students. The students learned some basic skills, such as proper hand soldering techniques, proper operation of the oscilloscope and meters, component identification, and a basic understanding of component functions, and each lesson came with at least one activity.

The schedule was broken into five main topics, and different projects were chosen in each class (*Lecture* and *Lab* topics are taken directly from the course syllabus)

(1) Basic electricity and electronics:

Lecture:
How electricity works; voltage, current, resistance; Ohm's law; AC and DC; resistors, capacitors and inductors; measurement instruments (scopes, meters, etc.)
Lab:
Measure the resistance of some resistors, our bodies & our friends; look at AC waveforms, check AC waveforms out with speakers

This module covered a lot of ground, so the lecture portions were very high level. Most of the explanations were during the lab session. There are a number of experiments that can show basic voltage and current. One favorite was the "Electricity Game" where students assembled a project while learning about current and voltage. The game involves a student passing a metal wand over a metal path trying to avoid contact; if contact is made, a buzzer will sound [3]. This project involves a long piece of copper wire

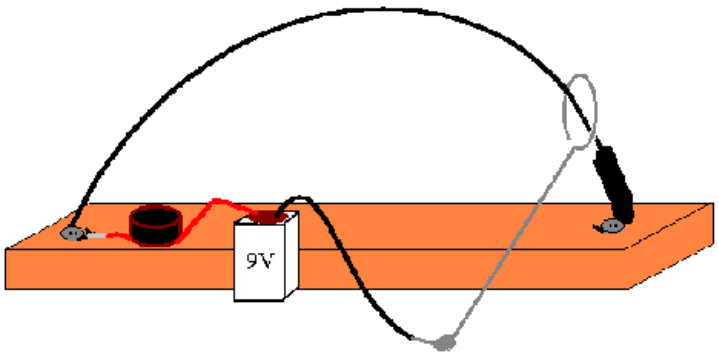

Figure 1: The Electricity Game

screwed to a board, soldered to a buzzer, to a 9V battery, and finally to a short piece of wire bent to pass over the long wire path. Some electrical tape or heat-shrink tubing at one end will let the wand rest without having to disconnect the battery. The instructor may wish to partially assemble this project in the interest of time.

It should be noted that 20+ buzzers in class will mean the end of all lecturing, so it is advisable to distribute the batteries at the end of the project.

Students also measured resistance of resistors (after guessing based on the color code), as well as the resistance through themselves and through their lab team joined hand to hand.

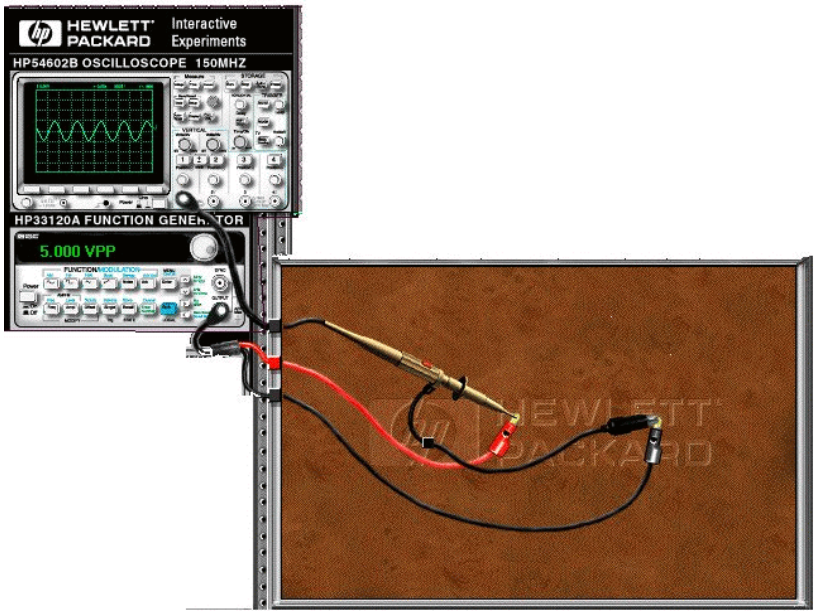

Figure 2: Display from Hewlett-Packard "Educator's Corner" CD ROM

Finally, to introduce AC voltages, the students studied speakers while viewing the waveforms on the oscilloscope. The students had a "hearing contest" where we measured the highest frequency they could hear, with a prize for the winning pair of students.

There are a number of sources for interesting graphics and interactive demonstration programs that help explain these principles in an efficient and interesting way and allow students with different learning styles to catch on to the concepts being presented [4].

(2 & 3) Hand Soldering, Electronics Manufacturing, Small Projects

Lecture:
How to hand solder the right way - work with an electronic manufacturing line in the Mobile Electronics Manufacturing Lab (MEML)
Lab:
practice soldering, build a project (to take home)

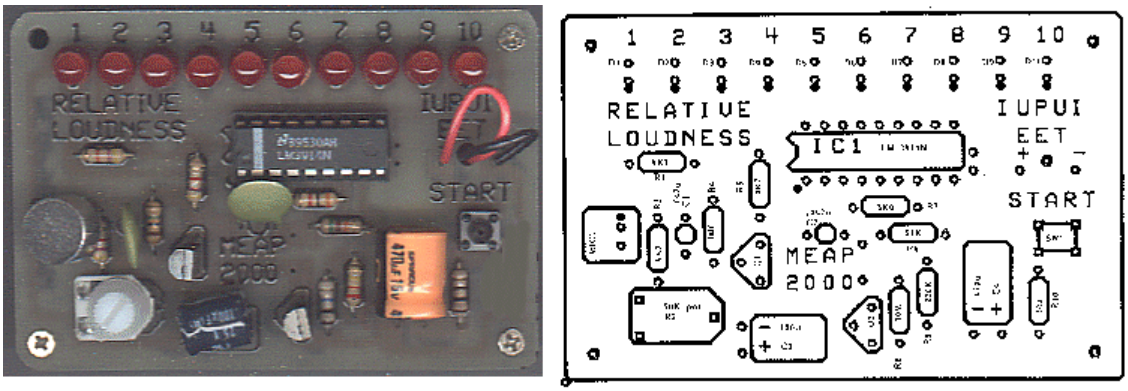

Figure 3: Relative loudness meter

For this module, we took advantage of some of the certified soldering instructors at

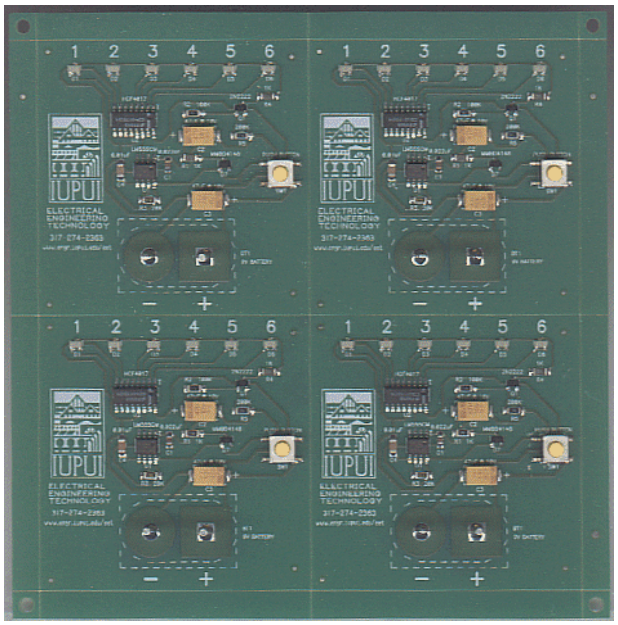

Figure 4: Random number generator (panel of 4)

IUPUI, and some of the audio-video resources available through the IPC (responsible for industry electronics assembly specifications) [5]. Students were taught the proper method of hand soldering, then the students built one or two projects soldering by hand or using the Mobile Electronics Manufacturing Laboratory (MEML) [6], a prototype scale electronics manufacturing laboratory in a trailer on campus. Projects that the students have built include a small audio amplifier (which came to be known as the "Gameboy amp"), a random number generator, a "loudness meter", and a digital thermometer. Some of these are shown here:

(4) Computers: Hardware & Software

Lecture:
Computer architecture, software, Internet
Lab:
Design our Web pages, tear apart (and hopefully reassemble) some computers

See course description on *A Peek Inside the Computer* for a description of this module.

(5) Special Topics

Lecture:
varied: Electric vehicles and electric racing, medical equipment, musical instruments
Lab:
tour the Formula Lightning Electric Vehicle Laboratory, lab with defibrulators

Students saw a race video of the IUPUI Formula Lightning electric race car, and toured the IUPUI Advanced Vehicle Technology laboratory. Students saw state-of-the-art battery technology, electric vehicles ranging from carts to an electric pickup, and a General Motors EV-1 production electric car.

Figure 5: The IUPUI Formula Lightning electric race car

Another lab session involved playing an electric guitar and looking at and modifying the output waveforms. while another lab session used a "defibrulator dummy" with a defibrulator to study some biomedical engineering technology equipment. Each student revived the dummy and recorded a strip chart to prove that they successfully revived their 'patient'.

A Peek Inside the Computer

The computer course is basically an expansion of module 4 of the *Electronics* class, with some new topics added. One reason that this course was developed was to give returning students a different experience. Students were given more advanced topics to look into if they had previously completed the *Electronics* course. This course has only run one time, so some future plans are included with the module descriptions:

(1) Low-level Software

Lecture:
Operating systems, programming, C language
Lab:
We'll get on the computers & use Microsoft Visual C++ compiler to write some C programs! (We'll stick with code that will work on any C compiler)

The students were given a crash course in computer programming, and given nearly functional code in C to finish and run. They also looked at some confusing code and tried to understand what it did. The next course should have more graphical applications for the students to try - dialog boxes, etc.

(2) Hardware I

Lecture:
What's in the computer! Storage (disks, Zip disks, hard drives), memory (RAM, cache), CPU, buses, etc...
Lab:
Take computers apart and reassemble them

Students were supplied with an excellent book for computer beginners - Computers Simplified[7]. Lecture basically followed the book while disassembling a computer. For the laboratory session, student teams were given a computer system to take apart nondestructively (in theory), then traded systems and tried to reassemble the computer. The success rate for one class was 1 of 6 successfully reassembled, although most of the assembly problems (memory installed incorrectly, loose connectors) could have been solved given more time.

(3) Software II

Lecture:
Internet, Browsers, Applications, etc.
Lab:
Build Web pages

Students had a homework assignment from the first day to bring in pictures to put on their web pages (scanned at home by the instructor). They were given a disk with their pictures, and they were posted to a server. Students were led through basic web site construction: adding code, titles, images, links, etc., and their finished pages have been posted complete with links to their scanned images[8]. Students repeating this activity from a prior class were given either more instruction and examples in C programming, advanced html or some beginning Java instruction. Next year, students will receive a stronger lecture dealing with inappropriate content in their pages which are posted in the instructor's web space in an attempt to avoid the problem which occurred with one of the student group pages.

(4) Hardware II

Lecture:
Continue looking into the computers, discuss scanners, printers, etc.
Lab:
Destructive analysis of computer hardware

This lab session was the highlight of the week for the students. Basically, students were given an assortment of tools and teams were assembled. The project involved identifying the main components of the hardware, which of course involved taking each component apart. Some of the pieces were distributed to the group members after the "destructive analysis" was complete. Teams did have to go in front of the class and give an oral presentation on a few of the items, including hardware they were able to identify and its function.

(5) Other Topics

Basically a repeat of module 5 in *Electronics*.

General Discussion:

In general, classes like Young Scholars are quite different than the standard college lecture. Multi-day overnight programs require a much larger investment from the student and parents; some parents and students can see the program as a full day activity to entertain the student. The program also has a high level of activity, and that can lead to some disruptive behavior. It may be necessary to have classroom monitors volunteer to take care of the non-teaching activities and help the students stay focused, especially in larger classes. Most of the students do much better when challenged by hands-on activities, especially some of the active learners who are looking for the opportunity to get away from the typical classroom experience.

There have been very rewarding experiences through these courses. Many of the students find an area that they knew little about before the class, and their performance was outstanding. Some of the students have sent email with additional questions months after the course was finished with questions on upgrading their web pages, showing a continuing interest in the material.

Future Plans:

A class for the Saturday Scholars program is under development - this program uses consecutive Saturday mornings and is geared towards the Junior Scholar age group (grades 5 through 7). This program should be offered in the spring of 2000.

Next Summer should find the EET department offering two classes again: an *Advanced Electronics* course (to be developed) and another *Peek Inside the Computer*, possibly with admission restricted to non-repeat students.

EET will work closely with Manufacturing Engineering Technology to offer a joint class next summer also, perhaps in Robotics or other small projects.

Conclusion:

It is important to work with area K-12 schools, unless your institution draws mainly from out of the area, or you have as many students as you need. Otherwise, a program like Young Scholars can work for your institution. The ideal situation would be similar to that of IUPUI, where your department adds a class to an existing program. Administering a program and developing a course or two would be quite a challenging task for one person to accomplish. A significant amount of development work must go into each course, and the work must start early to be successful. There are many resources to help plan laboratory experiences for the students - be sure to utilize them.

Be sure to plan your classroom activities with hands-on experiments, and be sure that any faculty who will work with these students is wiling to do so - they should be aware that these students are not in college, and may behave accordingly.

Finally, you may want to seek local sponsors, and you may want to contact local press to cover the class. Local sponsors can help with everything from supplies to summer salary which could offset the cost of building small projects, etc.

Bibliography:

1. "List of Recommendations from the 1999 Sections Congress", Institute of Electrical and Electronic Engineers (IEEE) Sections Congress Report, 1999.

2. Bottomley, L., Parry, E. "Exciting Children About Science and Engineering: The Science of Playgrounds", *Proceedings of the 1998 American Society of Engineering Educators National Conference*, 1998.

3. Rust, L., Palmer, K., and Finelli, C. "Electrical Escapades", *ASEE Division of Women Engineering Workshop: Engineering the Future: Introducing Pre-College Students to Engineering through Interactive Activities*, Workshop with ASEE National Conference, June 1998.

4. "Educator's Corner: Sharing Hewlett-Packard's Resources with Engineering Educators" CD-ROM, available from http://www.agilent.com.

5. URL: http://www.ipc.org/

6. Reid, K. "The Mobile Electronics Manufacturing Laboratory", *ASEE: Future Directions in Engineering Education: Proceedings of the Illinois/Indiana sectional Conference*, p. 91-95, 1997

7. Computers Simplified, the 3-D Visual Approach to Learning About Computers, 4th edition, IDG Books from MaranGraphics, c. 1999. URL: http://www.maran.com/.

8. URL: http://php.iupui.edu/~kreid1/.

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