BILINGUAL TECHNOLOGY EDUCATION FOR MIDDLE SCHOOL STUDENTS IN CHICAGO'S INNERCITY

Dale Reed[†], Eric Hamilton[‡]

ABSTRACT

Technology can be used to make scientific discovery experiences accessible and enjoyable to middle school students. In particular, computer technology can be used as an interdisciplinary tool to wield in mathematical and engineering exploration. In this program, middle-school limited-English-proficient students begin with an introduction to computer architecture, after which they assemble IBM compatible computers for use through the program. Students experiment in two distinct labs: digital electronics, and engineering design/control, concurrently learning programming in pascal. In engineering lab, students experiment using sophisticated LEGO kits, devising computer programs in pascal to provide software control. Students get to feel, touch, and interact with their engineered solutions controlled by the programs they write. The six-month program is jointly funded by the National Science Foundation (NSF) and the Department of Energy (DOE).

Key Features: Unusually sophisticated but successful and innovative middle-school curriculum; students build their own computers and their own machines, writing programs to run them; program is bilingual (English/Spanish) and is operated in close partnership with community organizations.

This report describes the Loyola/Aspira **Pr**e-Freshman **E**nrichment **P**rogram (**PREP**), an on-going bilingual educational program which integrates computer science, engineering, and physics in intellectually nurturing middle-school "high potential - low opportunity" Latino students. A highly interactive hands-on pedagogical approach, innovative curriculum, and interest-stimulating experiences are used to enable and motivate students to take college-preparatory courses in engineering, science, and mathematics, ultimately promoting their entry into science, engineering, and math (SEM) careers. Sponsored by Loyola University Chicago in conjunction with Aspira of Illinois and funded by DOE and NSF, the program combines a six-week commuter program with a thirteen-week academic year follow-up. Additionally, during the summer participants travel to area business and research centers, giving them an increased understanding of how technology is an integral part of everyday life in the workplace.

PREP is modelled after the NSF Loyola/Aspira Young Scholars Project, with the principal differences that it is run for younger students and is bilingual. As part of the Access 2000 NSF Comprehensive Regional Center for Minorities, **PREP**

† Loyola University Chicago, Dept. of Mathematical Sciences, 6525 N. Sheridan Rd., Chicago, IL 60626

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uses a Learning Center provided in part by the Amoco Foundation, with additional funding from Kraft.

Project Objectives

NSF projections indicate that the United States faces a shortfall of up to 700,000 scientists, mathematicians and engineers during the next fifteen years, and Hispanics are underrepresented by a four- to ten-fold factor in these professions. As part of the response to that problem, funding by NSF and DOE has been provided to this program to use technology to stimulate students' interest in scientific discovery. The target population for this program is under-represented minority students entering 7^{th} through 9^{th} grades, specifically students in the Humboldt Park area of Chicago, a predominantly Latino section of the city with a 58% high school drop-out rate.[1] The primary objective is that students' interest in science, engineering and mathematics is piqued as they interact with each other, learning to use computers, software programs and digital logic testers as *tools*.

Digital Electronics & Programming

The scope of the hardware design and circuitry lecture/lab components is rarely if ever found in pre-collegiate programming.[2] The material presented is extracted from Digital Electronics courses taught at Loyola and Northwestern Universities. The approach involves discussions and hands-on experience with gate level circuits through general block diagrams of computer architecture. Students are initially exposed to computer circuits in the first week of class when they assemble the Intel-based (MS-DOS) computer systems. Subsequently we discuss breadboarding techniques and combinatorial logic devices including logic gates, Boolean algebra and Karnaugh maps. Projects include designing and building a furnace controller to turn on the heat when any two-out-of-three thermostats in an apartment building turn on. Lab notebooks are monitored and graded

The Computer Science concepts are presented using the Pascal programming language. During lecture/discussion, material is presented, discussed, and then illustrated by having students in groups of two or three finish partially completed programs, working at the computers. These partially completed programs are carefully structured to lead students into implementing examples of the material discussed. Later in the lab component, students work more independently at the computers, writing programs which involve graphics and sound, again reinforcing the concepts they have just learned. The sequence of topics actually covered is the most orthodox part of the project, and includes programming basics, algorithm construction, data types, operations, and subprograms.

Lego / Pascal

The Lego/Pascal component is the students' favorite activity in PREP. It started as Lego/Logo[3] and has been modified by our staff to use the Pascal programming language rather than Logo. This modification allows students to concentrate on and reinforce only one programming language during the program. Students begin with the design of small electro-mechanical machines using Lego gears, wheels, motors, infra-red sensors, and touch sensors. Students built devices

such as a car which follows a line on a table using an optical sensor, a miniature assembly-line conveyor belt which automatically sorts Lego pieces into long and short, and a robot arm which is programmed to move a set of pieces from one point to another.

After building the devices, students write the programs to provide software control. As mentioned earlier, students encounter engineering and control problems as they learn to refine their designs to take into account the physical parameters of motor speed, gear ratios, leverage, loads, and piece strength. The Lego/Pascal component is one of the most powerful learning activities for the students because they have concrete motivation to master the Pascal programming structures necessary to do tasks which they can actually see. Students essentially get to *feel, touch,* and *interact* with the results of the programs they write!

"Student Investigations" As A Pedagogical Approach

In this program we emphasize enabling students "to experience the excitement of *doing science*." This program provides an environment requiring extensive hands-on experience: students spend over half (56%) of their time in either a computer laboratory developing computer programs, a digital electronics lab building and electronically experimenting with relatively sophisticated microcomputer systems, or a Lego/Pascal lab developing their own computer-controlled devices. Students are consistently led to view learning as a pursuit of discovery rather than as a pursuit of information.

This year Access 2000 provided funding for three teachers to be involved in the PREP program *as participants*, experiencing first-hand the SEM interactive learning environment. The teachers worked through additional Pascal curriculum with the help of individualized tutoring by the PREP program staff after the students were gone for the day. The teachers were payed a $1,000 stipend for participating in the program and were given an IBM compatible computer to keep in order to give impetus to them replicating the same types of learning activities in their *own* classrooms. Our belief is that in the long term, technology will increasingly prove to be an essential communication aid in the classroom.

We have seen in **PREP** how Latino students become highly motivated to learn when they are equipped to use technology which is also made available to them. *Technology engenders excitement over scientific discovery.*

Notes

1. Network for Youth Services (NYS), 1991 report funded by the MacArthur Foundation and the Allstate Foundation. (312) 227-0416
2. During last year's PREP field trip to Northwestern University's school of engineering, students noticed that class lecture notes left up on the blackboard in a classroom corresponded exactly to digital logic material they had learned in the program!
3. Contact Lego/Logo at 1 800 527-8339

This work was partially funded by the Department of Energy (DE-FG05-91ER 79029) and the National Science Foundation (HRD -9255135)