

# Loyola/Aspira PREP: A Bilingual Educational Program

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This report describes the Loyola/Aspira **Pre-Freshman Enrichment Program** (or simply, **PREP**), an on-going bilingual educational program which integrates computer science, engineering, and physics in intellectually nurturing Latino students of high potential but limited opportunity who are entering grades seven through nine. 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 sophisticated R&D 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.

The senior staff brings an interdisciplinary approach to introducing computer science to students from both hardware and software perspectives. Students experiment in three distinct forums. First, they assemble IBM-compatible microcomputers and then perform digital circuitry experiments on the computers and other electronics equipment. Second, they experiment with computer concepts through programs they write in the Program's software science introduction. Third, they experiment with small computer-controlled machines, building them from the component level on up, writing the controlling programs themselves. Additionally, during the summer participants interact with role-models and explore possible science, engineering, and math (SEM) careers in several arenas. A trip to Argonne National Laboratory gives students a taste of scientific research environments, and visiting area Universities gives them a picture of minority opportunities in SEM higher education. A trip to a local utility company helps students visualize engineering career paths, while a trip to a stock-market trading firm gives them an image of advanced computer science applied to the business world.

## Six Project Objectives

The target population for the program is "under-represented minority students" entering 7<sup>th</sup> through 9<sup>th</sup> grades, specifically Latino students in Chicago who can be characterized as "high potential - low opportunity." The primary objectives are that students' *interest* in science, engineering and mathematics will be piqued as they participate in the program by:

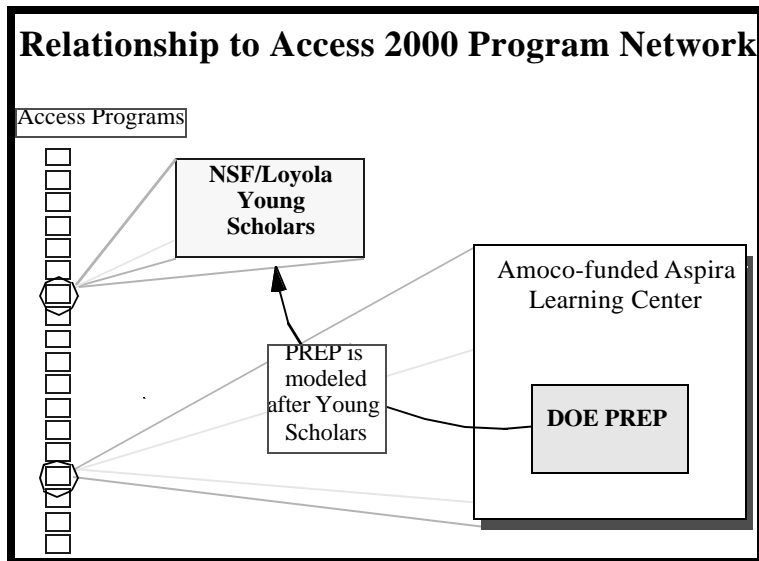
1. *interacting* with interesting and interested professionals in various fields of computer science, mathematics, engineering and physics at a variety of facilities in the Chicago area;
2. *assembling* an IBM-compatible microcomputer from components;
3. *acquiring* an appreciation of the profoundly interdisciplinary nature of computer science and its every-day life applications, and gaining a comprehensive introduction to the physics and mathematics in hardware and software;
4. *experiencing* engineering problems and solutions using their own computer-controlled devices;
5. *envisioning* educational and career opportunities in computer science; and:
6. *acquiring* computer science skills at a level enabling them to receive special high school credit.

*This Program's overall mission is to intellectually nurture Latino students of limited opportunity, providing them with experiences which enable and motivate them to take college-preparatory courses in science, engineering, and mathematics, ultimately facilitating their entry into sophisticated R&D SEM careers.*

**PREP** does not attempt to duplicate any typical course in any elementary or secondary curriculum. It is, frankly, an enrichment experience that so cuts across disciplinary boundaries and so involves academic, business, and community structures that it is not realistic to expect schools to offer the same type of opportunity. While the activities are non-traditional, we do collaborate very closely with the city schools and have embraced some traditional measures of program rationale and program success. Central among those measures is the College Board's Advanced Placement (AP) program. Only eleven (11) Hispanic (Latino) students in the entire state took the AP Computer Science Exam in Computer Science (Level AB), and five of those eleven students were participants in the Young Scholars Project on which **PREP** is indirectly based. The disparity extends beyond severe under-representation to under-preparation -- Hispanic students taking the AP Examinations in Computer Science scored, on average, more than one full point (out of five) lower than their non-Hispanic counterparts. None of the city's predominantly Latino high schools are among the few in Chicago which even offer AP Computer Science.

## **RELATED PROJECTS**

**PREP** fits into a larger Amoco-funded initiative which itself is part of a much larger NSF-funded Regional Center for Minorities called Access 2000. **PREP** is an "anchor" program in one of the two Aspira Mathematics and Science Learning Centers funded in Chicago under a \$70,000 grant from the Amoco Foundation. The Aspira Mathematics and Science Learning Centers form one of eighteen programs in the Access 2000 network, which involves five universities, the Chicago Urban League, Aspira of Illinois, and Argonne National Laboratory. Access 2000 is beginning its third year of a six-year, \$3.9M commitment from NSF to address minority under-representation.



### *NSF Young Scholars Project*

As illustrated above, **PREP** is modeled after a NSF Young Scholars Project (YSP). Funded since 1988, the NSF/Loyola University Young Scholars Project offers high school sophomores and juniors a six-week summer program in math-based computer science with an academic year follow-up and is the curriculum template for this project. As alluded to earlier, half of the 1989 African-American and Hispanic students in the state of Illinois who took the AP Examination in Computer Science were Young Scholars participants. The project has been the subject of approximately fifteen newspaper articles and was featured in a WLS-TV (ABC) documentary on minority education, and its participants have been honored in a special ceremony with the Mayor of Chicago and the Chicago City Council. The project has thus garnered significant recognition. More importantly, participants indicate markedly increased intentions in pursuing science and engineering careers as a result of the project.

### *Description of PREP*

Currently in its second year, **PREP** is a fully bilingual summer and academic year follow-up commuter program for Chicago Latino middle-school students, giving them experiences in computer science and its related disciplines. **PREP** has been the subject of newspaper articles and was featured at length on a Chicago T.V. news program. A **PREP** publicity video was created at the request of DOE during this last year and was shown in a Chicago public schools area-wide principals meeting. NSF has requested the master print of this video to incorporate segments as footage into *their* educational programs video.<sup>1</sup> **PREP** participants are (and will be) tracked by the Access 2000 consortium through their high school and college years.

### *Differences Between PREP and Young Scholars*

**PREP** offers students the same opportunities as the Young Scholars Project, with four important differences. First, the students are two to three years younger: the curriculum is consequently slightly less sophisticated and is presented over a three-month rather than eight-month follow-up. Second, most of the activities take place in one of the Amoco-funded Aspira

Learning Centers in the Latino community, rather than on a university campus. Third, the activities are bilingual. Fourth, the computers the students assemble are used in other Access 2000 projects and in other Aspira Learning Center activities, so the students are not able to take them home to keep for themselves, as in the NSF/Loyola Young Scholars Program.

### ***Description of Aspira Math and Science Learning Centers***

**PREP** is housed in one of the two Amoco-funded Learning Centers, located in the heart of the Humboldt Park area of Chicago, at a facility which is shared by the Chicago Public Schools. The Learning Centers themselves house a core set of activities calculated to promote the interest and skills of Latino youngsters in science and mathematics. These include visits from retired Argonne scientists, science experiment sessions using material developed at the University of Illinois (Chicago), and systematic use of a comprehensive city-wide directory of accessible math and science programs to encourage students and their families to persist in science and engineering career hopes.

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 paid 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.

Kraft has announced approval for infusing PREP with \$6,000 to enhance the project. In particular, this will allow for two additional students, two additional computers for the lab, expansion of the Lego/Pascal labs, and the development of middle-school level Spanish computer science curriculum.

## **PROGRAM DESIGN**

As mentioned earlier, **PREP** consists of a six-week summer commuter program followed by a thirteen-week Wednesday afternoon program during the fall semester. In order to create a mutually encouraging and safe group atmosphere in which the students can experiment and learn, we take the students through an outdoor obstacle course on the first day. This activity induces students to interact extensively with each other, building a strong sense of group identity.

### ***Computer Science Content***

The Computer Science concepts are presented using the Pascal programming language. Pascal is used in the Advanced Placement program and is widely recognized as an excellent teaching 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 learned. The sequence of topics actually cov-

ered 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 was the students' favorite activity last year in PREP. It started as Lego/Logo, an educational package developed by Seymour Papert at M.I.T. 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. Last year in PREP students built:

- A car which followed a line on a table using an optical sensor;
- A miniature assembly-line conveyor belt which automatically sorted Lego pieces into long and short;
- A robot arm which was programmed to move a set of pieces from one point to another;
- A washing machine model with sensors to rotate the washing drum only when the door is shut; and
- A ferris wheel model which stops at the appropriate spots, ostensibly to let passengers on and off.

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!

### ***Hardware Design and Circuitry***

The scope of the hardware design and circuitry lecture/lab components is rarely if ever found in pre-collegiate programming.<sup>2</sup> 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 consisting of: 20 chips (including memory), three interface cards, power supply, case, floppy drive components, keyboard and monitor. Subsequently we discuss breadboarding techniques and combinatorial logic devices including logic gates, Boolean algebra and Karnaugh maps.

The key to this approach is the integration of the lecture material with the hands-on experience in the laboratory, giving students a basic working knowledge of computer hardware components by the end of the summer. Students are required to keep careful records of their lab experiences in a lab notebook. Experience with the PREP program has pointed out the need to teach students organizational and note-taking skills. We interact on a regular basis with students

in this area by grading their lab notebooks once a week. These notebooks will contain homework assignments, a record of lab experiences, lecture notes, and handouts.

### ***“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.

### **Career Exploration Activities**

An outstanding lineup of computer science, engineering and mathematics practitioners hosted facility visits and tours for Program participants. In most cases, our hosts were Latino and specifically addressed the socio-economic situation of our Project participants. The sites were as follows:

- 1. Argonne National Laboratory** - a scientific research environment; displays and models of on-going research projects; demonstrations of both superconductivity and high-resolution computer graphics; supercomputers;
- 2. Chicago Research and Trade (CRT)**- the opening of the grains trading floor at the Chicago Mercantile Exchange (narrated in Spanish); a tour of the technical trading office of CRT; examples of how computer technology is used in a business environment;
- 3. People’s Gas** - A tour of a central work facility including a welding shop and a computerized dispatch center; showing how gas lines feed into everyone’s homes; gas storage technology;
- 4. Northwestern University** - a university environment; a tour of the facilities; graphical software demonstrations in various computer labs; a presentation on engineering scholarship opportunities for Hispanic students.

Besides the above four, the first day of the program we took a “group building” field trip to a ropes course, as mentioned earlier. In each of the above sites we had a private meeting with our hosts, who reflected on both his/her personal career choices and how those choices were pursued, as well as his/her anticipation of technical and societal trends due to advances in computer science and engineering. Students were asked to reflect on and to articulate their own career expectations and hopes, as unevenly or vaguely formed as they might be. There is no requirement that students will “buy into” a SEM career based on their experiences in the program, but through these activities students see a number of available options leading to several different types of stimulating and productive careers.

## **Unorthodox Program Features**

*A notable feature of this program is that it is bilingual, with instruction, hand-outs, tutoring, and field-trips being communicated in both Spanish and English.* All of the students speak Spanish as their native language, with varying degrees of English proficiency. Having a bilingual program staff allows us to provide an exceptional educational opportunity to high-potential students who would not be able to participate in any other special programs because of the language barrier. We encourage our students to make the transition into communicating effectively in English as they head towards high school. All technical terms are presented in English.

Many capable students in Chicago miss the SEM “fast-track” by being shunted off from Algebra courses in junior-high school. In order to help combat this situation, we gave a brief presentation and handout to students’ parents at our closing ceremony, describing what subject areas students could take during each year of high school, ultimately leading to SEM university studies.

A guiding Project philosophy is that the experience it offers not only assists participants in the career choice process, but that it would also equips them in practical ways to more successfully pursue the educational choices that provide the foundation for their careers. For this reason we award a high school computer science course credit through the Board of Education. We also pay students a \$120 stipend which helps defray their transportation costs in getting to-and-from the Project site, as well as defraying possible summer employment income. The stipend and the issuing of course credit remains subject to carefully defined contingencies: absences and tardiness during the summer affect the amount of the final stipend, and absences during the school year affect the course grade assigned for high school credit. Parents and students consider these terms to be reasonable and agree to them in writing before the program begins.

## **RECRUITMENT, SELECTION**

The target population for this program is “high potential / low opportunity” Latino young men and women who are entering grades seven through nine, particularly those who might not yet be accepted in other programs because of an English language barrier. The minimum expected standard will involve students falling in the top half of their classes, although others are also considered with appropriate teacher recommendations. Bilingual student applications are used to help discern the students’ abilities, aptitudes, and background through a combination of essay questions and check-off lists. Because grades are often not a reliable barometer of ability for minority middle-school students, we depend heavily on teacher recommendations. These recommendations provide us with a picture of the applicant’s language abilities, maturity level, and intellectual ability. Applicants come from the Humboldt Park area of Chicago, a predominantly Latino section of the city with a 58% high school drop-out rate.<sup>3</sup>

Recruitment occurs through a combination of personal classroom visits, mailings to area schools, Chicago Public Schools Bulletins, and the Loyola/Aspira PREP publicity video. Access 2000 now publishes a directory of all area science programs, and distributes that directory (with applications) to each school and local school council in the city. Project announce-

ments and invitations for applications are sent directly to the Principals, Bilingual Program Directors, and Math and Science teachers in the twenty-three Humboldt Park area schools. Recently the publicity video for Loyola/Aspira PREP was shown at a Chicago Public Schools area-wide principals' meeting and there was a tremendous response by the principals, who would like as many of their students as possible to participate. Project announcements are also included in the periodic bulletins of the Chicago Public Schools. Recruitment also occurs through Aspira of Illinois and the Deanery 5 Youth program, both trusted community organizations with extensive personal contacts in the Latino community, particularly for those students in parochial schools.

Both years we have had four student applicants for each available slot. All of the applicant review and selection is conducted by the PD with input from Aspira, ensuring that the group is balanced by gender, with particular attention to women.

## **ANTICIPATED RESULTS**

Our overall intention is *to provide a sustained and measurably beneficial impact* on the participants' interest and persistence in pursuing science-based education and careers. Measuring this impact is being done in part through The Center for Talent Development at Northwestern University, which works with Dr. Hamilton conducting the evaluation and tracking component of the Project, as part of their responsibilities in the Access 2000 consortium. The Project also implements a number of very conventional evaluation techniques. Student notebooks are graded weekly, and a final exam is given. Additionally, students have to complete their computer programs in a working fashion. All of these assessments are incorporated into grades that we have arranged to become part of the student's official high school record, as an added reward for participation. Pre-and-Post testing will be used to evaluate participants' changes in attitude over the course of the project.

### ***Increased Interest***

We expect that over 95% of the participants will indicate significant and sustained increases in interest in science and mathematics as a result of **PREP**, using an interest-measure designed under NSF contract by the COSMOS Corporation in Washington. 100% of the current NSF Young Scholars students have reported such increases in interest in science and mathematics.

### ***The Advanced Placement Exam***

Since we do not intend for our students to cover the entire AP curriculum, and indeed about half of our curriculum is not related to the Advanced Placement (AP) Exam at all, most youngsters completing **PREP** will require further study (in grades 10-12) to prepare for the AP exams. We intend for them to do that. If necessary, we will provide further preparation for them through any of several mechanisms in the Access 2000 network. By 1994, we expect the cadre of 1992 **PREP** participants to at least double the current statewide participation in the Computer Science Examination Program, at both Level AB and Level A. This implies at least 11 out of the 27 will take Level AB, and another 11 will take at least Level A. (Over 90% of the students in the Young Scholars Project take either or both of the AP Exams in Computer Science, and meet

or exceed the performance of their peers city-wide.) We expect these students will achieve higher average scores than their counterparts statewide, Hispanic or non-Hispanic. These are ambitious but tangible goals.

### ***“Tracking” Students***

These goals are also attainable. The Learning Center in which **PREP** takes place remains available, with computers, for students to continue their studies. Equally important, the Learning Centers, as part of the larger Access 2000 network, include staff which will be working with students for several years after their initial contact -- these students are *followed*. This is one of the two principal advantages to funding this activity in the context of a comprehensive regional center for minorities -- we systematically “stay with” or “track” these students. (The other principal advantage is the enhanced resources at the Learning Centers and elsewhere in the Access 2000 network which become available to students as they enter any Access 2000 program.) These students are encouraged to continue in other science-based enrichment programs. They come to share the expectation that before they graduate they will take the AP Examination. They will have the opportunity to take AP courses -- if not at their schools, then, as mentioned, through other Access 2000 activities.

Enhanced interest/persistence and increased AP Exam participation and achievement are the two areas of anticipated results which can be most readily measure. They are also consequences of achieving the six program objectives. Though achieving those objectives is less measurable, they are nonetheless powerful outcomes. Loyola/Aspira PREP students take ownership of the sense that science-based careers are natural and accessible life paths which they can pursue.

### **Notes**

1. The request came from Walcoff & Associates, under contract by NSF’s EHR Directorate to produce the video.
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. Network for Youth Services (NYS), 1991 report funded by the MacArthur Foundation and the Allstate Foundation. (312) 227-0416