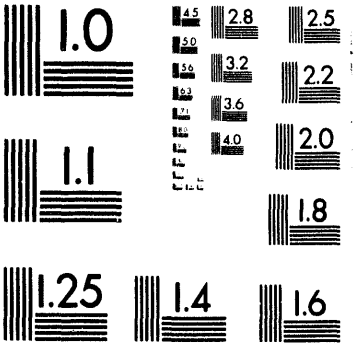
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PREP Program
HIGH SCHOOL URBAN ENGINEERING
Technical Progress Report
Summer 1993

Introduction

To ensure the availability of a highly trained scientific and technical workforce, priority must be given to the promotion of the increased participation of those underrepresented in science, mathematics and engineering. There is increasing concern in both the public and private sectors about the need to prepare underrepresented groups for careers in science, engineering and related fields. Studies indicated that in this decade these fields will face a shortfall of 500,000 to 1.5 million workers for a variety of reasons. Two demographic facts both drive and exacerbate this situation. First, the "baby bust" will dramatically decrease the population entering the workforce. In addition, the composition of the workforce is changing. During the next ten years, 85% of new entrants into the labor market will be minority, women, and recent immigrants. Only 15% of the entrants will be from the traditional professional labor pool of white males. The productivity, competitiveness, and economic stability of this nation may be determined by what the 85 per cent is prepared for and how well they are prepared.

Part of the problem of the dramatic underrepresentation of minorities in science and engineering is the unfamiliarity of the youngsters with the role of science and engineering in urban life. This, coupled with often inadequate counseling and underdeveloped curriculum, limits the number of minority students even considering science or engineering as career possibilities, and preparing themselves in high school with the proper academic courses.

The national underrepresentation of minorities in science and engineering is compounded in the greater Newark area by the pressing need of Blacks and Hispanics to take leadership positions in these areas to solve pressing critical urban problems in such areas as transportation, planning, and the environment.

The primary objective of the Urban Engineering Program at the New Jersey Institute of Technology is to introduce the students to the excitement of science and engineering as potential career opportunities, and to encourage the youngsters to adequately prepare in high school and in college for such an attainable endeavor. Through the course work, workshops, projects, guest speakers, and laboratory experiences, the students are not only introduced to the problems in urban areas, but also are introduced to the tools and analysis available to solve such problems.

The Directors of the HSUEP program are Dr. Harold Deutschman, Professor of Civil and Environmental Engineering and Dr. Howard Kimmel, Assistant Vice President for Academic Affairs, Pre-college Programs and Distance Learning. Faculty members and students from NJIT and high school teachers from the Newark School System were also involved in the program.

Overview of the Program

This past summer, 50 high ability students, most of whom were from Newark and surrounding communities, were offered an opportunity to learn about career opportunities in science and engineering. The program was sponsored by the U.S. Department of Energy, with additional support from Exxon Foundation, Mobil Research and Development Corporation, New Jersey Bell and Public Service Electric and Gas Company, and NJIT.

The NJIT campus, as a base for launching and maintaining such a program, has been ideal. It is central to several high schools near the heart of Newark, a city whose urban ills are all too familiar to local students. Although especially attuned to existing problems, most of the participating students are unfamiliar with the role that technology can assume in solving them.

In addition to the lectures, computer programming, math and science enrichment, urban projects and technical writing and communication, the program included workshops conducted by engineers from local industry, field trips, and career seminars.

The students participated in a field trip to New Jersey Marine Science Consortium at Sandy Hook, NJ. and to the Liberty Science Museum.

The purpose of the workshops is to alert students to various career opportunities and to supplement the subject matter covered in the classrooms. The seminar speakers were:

Mr. Frank Polizzi, NJIT;
Mr. Elliott Weinstein, Professional Planner;
Mr. Joseph Staiger, Professional Engineer;
Dr. David Kristol, Chemical Eng. & Chemistry, NJIT;
Ms. Angela Armerding, Pre-college Programs, NJIT;
Dr. Fadi Deek, Computer Science, NJIT;
Ms. Maria Kihiczak, Admissions, NJIT;
Ms. Dominique Clark, Cooperative Education, NJIT;
Mr. Carlos Ontaneda, EOP, NJIT;

Rationale and Objectives

The summer 1993 High School Urban Engineering Program (HSUEP) was designed to attract high ability inner city students who have demonstrated interest in furthering their development in science and/or engineering. The program had, as its major thrust, "The Engineering Approach to the Solution of Urban Problems." Inherent in such an approach are two fundamental goals:

(1) To offer exposure to relevant topics in urban engineering.

(2) To have the student realize that engineers solve problems which affect the quality of life in urban areas.

It is through this dual scientific and humanistic approach that the program attempts to stimulate talented youngsters to pursue a degree in engineering.

Major Objectives of the Program

There are six major objectives on which the program is based:

(1) To stimulate talented students' interest in scientific and engineering activity as related to urban problems.

(2) To provide students with an insight into the field of urban engineering.
(3) To offer students a perspective of how engineers and scientists function as problem solvers.
(4) To demonstrate the relevance of science and engineering as promising, interesting, and important careers within the grasp of the students.
(5) To encourage the academic preparation necessary for successful participation in science and engineering.
(6) To teach these future leaders to be better citizens in an environmental, political, and social sense.

Recruitment and Selection of Candidates

Recruitment of Candidates

Flyers describing the program were mailed to the science, mathematics and guidance department chairpersons at all of the high schools in the following areas: Bergen, Essex, Hudson, Middlesex, Passaic, and Union Counties. Flyers were accompanied by application and recommendation forms which could be duplicated if the need arose.

To be considered for admission the applicant had to

- have completed the eigth or ninth grade by June of 1993;
- live within commuting distance of NJIT campus;
- furnish a complete application form by May 1, 1993.

Selection of Candidates

The selection of students was based on

- recommendation from a math and science teacher;
- recommendation from guidance counselor;
- scholastic record;
- PSAT or SAT scores;

Two hundred and twelve students submitted applications and were interviewed, of those fifty students were accepted and completed the course.

ACADEMIC COMPONENT

Lectures, laboratory sessions, field trips and general teaching activities were conducted and supervised by NJIT faculty and staff members and students and high school teachers from the Newark School System:

Abladey Adjoga-Otu, NJIT
Angela Armerding, NJIT
Ana Bayas, NJIT
Charles Bower, NJIT
Paul Cutrino, East Side High School, Newark, NJ.
Beth Ann Ebbler, East Side High School, Newark, NJ.
Doris Fleischer, NJIT
Juanita Hamlette, NJIT
Diana Muldrow, NJIT
Amit Rathod, NJIT
Michael Shine, NJIT
Neil Williamson, Barringer High School, Newark, NJ.
Gwendolyn Williamson-Odom, NJIT

DESCRIPTION OF COURSES

A. Mathematics and Science Subjects

These courses were designed to strengthen the students' background in areas of basic science and mathematics that are important for success in their own schools and future college programs in science and engineering. Since thorough coverage of these areas were not possible in the limited time available, only selected topics relevant to engineering and technology were covered. Students were grouped in the math and science classes according to their background in the subjects.

The topics that were covered included:

1. plane trigonometry--
   a. trigonometry of the right triangle
   b. angles and their functions using trig tables
   c. reference angles and their uses
   d. trigonometric identities.
2. calculus--
   a. definition of average rate of change of function, solution of problems with scientific applications
   b. the derivative-definition, geometric inter-interpretation, and the delta process.
   c. applications of the derivative
      1) average velocity
      2) instantaneous velocity
      3) acceleration
   d. equations of tangent and normal lines
   e. successive differentiation with scientific applications..

The science lectures emphasized topics of particular relevance to engineering, including basic concepts in mechanics, chemistry, and measurement of physical phenomena. The chemistry lectures included basic

concepts of chemical reactions, composition of matter and topics relevant to environmental engineering and energy sources (e.g. composition of water supplies, water pollutants, air pollutants, related analytical methods, thermochemistry). The science lectures included:

1. scientific measurements;
2. atomic theory;
3. chemical and physical properties of elements;
4. chemical mathematics;
5. physical and chemical mechanisms of a chemical reaction;
6. introduction to carbon chemistry.

Laboratory instruction was a vital component of the science program. The laboratory sessions were held in the freshman chemistry labs in Tiernan Hall, and gave the students the opportunity to learn proper scientific techniques and the correct use of laboratory equipment. These sessions were carried out not only in order to increase the student's ability to handle scientific equipment, but also to prove ideas and concepts covered in the classroom.

Sometimes laboratory experiments were done in partnership of two or three students working together. This method was beneficial in terms of teaching cooperation and team effort, and also the participants enjoyed working together and learning from their interaction.

Topics covered during the science laboratory exercises included:

1. basic laboratory procedures;
2. recognizing chemical reactions, types of chemical reactions;
3. properties of acids and bases;
4. factors affecting rates of chemical reactions;
5. analysis of chemical ions (flame test);
6. heat of reaction;
7. measuring specific heat;
8. chemistry of household products and naming carbon compounds.

B. Urban Planning/Architecture

In this course students are provided with an introduction to urban planning/architecture. Urban planning lecture sessions delve into the techniques involved in urban revitalization within the context of urban architecture. Students are introduced to the field of architecture, and its many applications to the solution of urban problems.

Lecture and laboratory sessions emphasize building designing--both practical city renewal and futuristic "megapolis" design concepts.

The six-hour architecture curriculum was divided into daily topics as follows:

DAY 1

Introduction: What is design?--Program, concept, structure, materials, building systems, budget, legal requirements, aesthetics, context.

DAY 2

Assignment: A well-designed object--each student is to bring in a well-designed object and explain to the class why they consider its design to be excellent (shape,

use, material, cost, etc.); show examples of conceptual and working drawings for various projects, i.e. graphics as expression of concept, development of concept, design specifications, legal responsibilities of architecture.

DAY 3

Student presentations of their well-designed objects. Assignment: Favorite space--each student is to draw the space in which they spend the most time; methods of drawing space--plan, section, elevation perspective; show examples.

DAY 4-5

How to use architectural tools--scale, trace, triangle, templates,; how to construct a perspective grid; students work on project; Assignment: students are to analyze their space, make at least three design changes to make it a better place in which to spend time and represent those changes graphically (overlays or separate drawings).

DAY 6

Presentation of individual work to the class; critique of graphic expression and design decisions.

C. Transportation

This module emphasized the relationships between transportation and city growth and development. The student learned the role that transportation has taken in shaping and developing the modern city. In addition, the transportation problems of the cities and potential solutions such as staggered work hours, expressway ramp metering, exclusive bus and car pool lanes and car pooling were discussed. The high school students applied mathematical equations to solve a typical ramp metering problem in which a number of entrance ramps were metered to enable the expressway to flow at a maximum capacity.

The students also learned how to use mathematical tecnniques for the optimum design location of shopping centers, hospitals, parks, and recreational centers and employment centers.

The students developed concepts for a new city, designed for the future, hopefully eliminating the mistakes of the past and integrating its transportation and land use functions so that the quality of life in the city is greatly improved (compared to current ones). The cities had such features as car free downtown areas, bus loops through each neighborhood and to the downtown areas and major attraction centers such as sport complexes, gambling centers, and recreational centers, and also provided a transportation link to each of these centers.

D. Energy Systems and Environmental Science

The energy problem and environmental impacts were considered in a technological sense. Energy sources, methods of generation, storage, and conversion were studied. Emphasis was placed on combustion energy sources, which included fossil fuels, solid waste, biomass, and hydrogen. Alternative and future energy sources, conversion, and storage systems, including batteries, fuel cells, nuclear energy (fission, breeders, fusion), and solar energy were discussed. Energy conservation was considered in detail. The operation of an electric generating plant was studied.

In the energy laboratory the group was involved with making determinations regarding the efficiency of transforming various forms of energy into other forms (e.g. chemical and electrical to mechanical, etc.).

In the environmental science course, the environmental problems facing future engineers were presented. Water supply, waste water treatment, and air pollution were the main topics covered in the lectures and discussions. Water supply topics included potential uses of water, availability of water supplies, methods of forecasting water demands and future water needs. Wastewater treatment was discussed by stage of treatment (i.e., primary, secondary, and tertiary).

In the air pollution laboratory samples were collected by the students near their homes and analyzed for concentration of particulates and trace metals in the particulates by chemical methods. The samples were also studied under a microscope.

E. Computer Science

The purpose of this project was to introduce students to the field of computer science, and to indicate the many applications of computer programming to the solution of urban problems.

At the Pre-college Microcomputer Laboratory, dedicated solely for use by Pre-college Programs, the students were able to obtain hands-on experience with microcomputers and their supporting software; IBM-PC terminals using IBM Advanced Basic with PC-DOS support and ten AT&T 6300 PC Terminals using AT&T GWBASIC with MS-DOS support software

During the summer session each student group was assigned to six two hour sessions of computer science over a two week period. The first hour consisted of lecture and discussion concerning the day's topic and the second hour was a laboratory session dedicated to problem solving on assigned projects.

Near the completion of the summer session, when students had acquired sufficient programming knowledge and experience, they were allowed to select an individual programming assignment. The students were given a minimum of two complete classroom sessions and any time they needed in the micro-computer laboratory in order to complete the projects.

At the end of the program each participant was given the opportunity to discuss and demonstrate her/his project and to explain the method used to solve the assignment.

F. Technical Writing and Communication

This course module was designed to give students an introduction to the history of the English language, focusing on how language evolves as a result of accidents of history and usage. It was also noted that it is inherent in human beings to create a language with a logical grammatical structure. Students learned to differentiate those aspects of language which are taught from those we intuit because of our legacy as human beings.

All students wrote journals and received critical comments on their work. For some students, the journals were an opportunity to state their grievances and celebrate their successes; for others, the journal served as a diary to express very personal responses to people and situations; and for

still others, the journal was a way of analyzing the day and discovering its significance.

Finally, students worked on verbal presentations by means of mock interviews. College applications were filled out by the participants who where then interviewed by a "college admissions officer". As the process went on, students seemed more and more confident, articulate and forthcoming in their answers.

G. Major Project--Design

The field of civil engineering was introduced as it relates to land use, site development and transportation planning. A basic overview of land use and zoning regulations was presented, especially as it relates to the classification of roadways that service various land uses.

With a background of site development principles as to setback lines, parking requirements, local zoning ordinances, and topographical and environmental constraints, the students (in small groups) designed sites for office and commercial uses. The students designed the sites considering grading, storm runoff utilities. They designed the parking spaces, driveway and internal roadway design, and loading bays.

FOLLOW-UP ACTIVITIES

Program directors, administrative and teaching staff maintain contact with students to provide assistance in such matters as filing of applications to respective colleges and universities, providing letters of recommendation and general counseling, as well as any other services which the students may deem pertinent.

Students participating in the program have expressed a strong desire for academic year assistance. Students are encouraged to apply to our academic year pre-college programs and are also invited to attend any other science or career workshops offered at NJIT. Indications are that not only do students benefit in such a relationship, but the program and NJIT benefit as well.

EVALUATION OF THE PROGRAM

It is strongly felt that we met all of our objectives in the 1993 Urban Engineering Program. This, in particular, was evident in the students' evaluations and in the students' enthusiasm throughout the program. In addition to this, the favorable comments from the visiting scientists and engineers involved with the course, and the special recognition given by all our visitors and guests at the level of achievement of the students as a result of the presentations, model city, and workshops, leads us to believe in the merits of the program.

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